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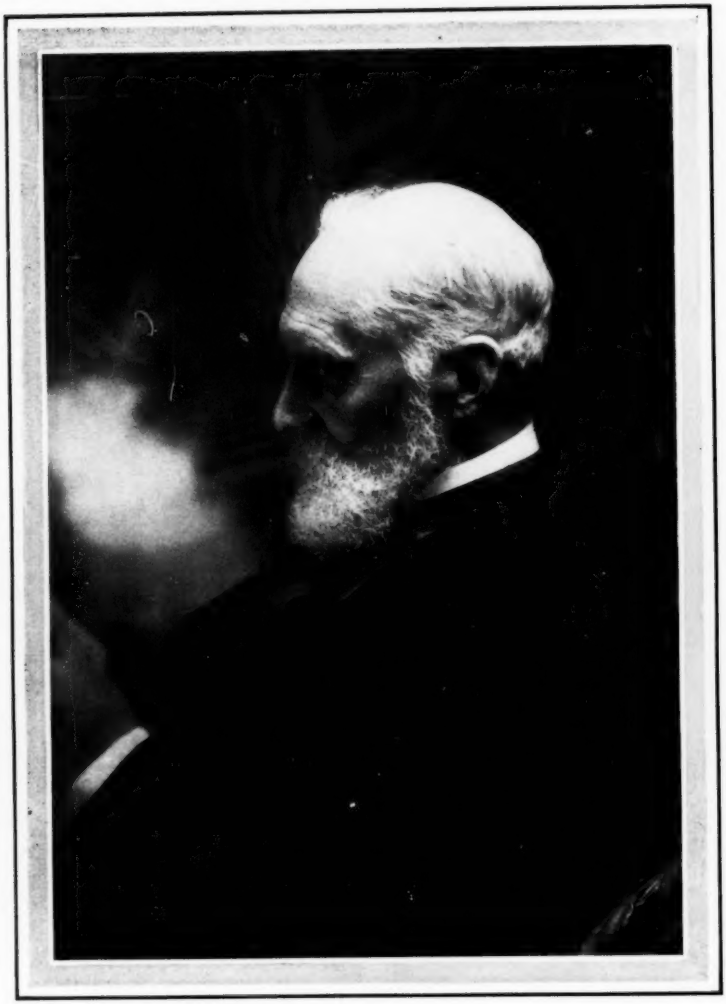

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THE RT. HON. LORD KELVIN, F. R. S., ETC.

THE WORLD IS ITS FIELD.

THE ENGINEERING MAGAZINE

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LORD KELVIN. HIS WORK AND INFLUENCE.

By Francis Bacon Crocker.

With an Editorial Introduction.

PROFESSOR CROCKER gives in the following pages a sketch, brief but full of character, of the greatest figure in the contemporary world of physical science. It is a page from the note-book of a busy worker in the field of electrical engineering, which Kelvin did so much to clear, define, and develop. And for this reason it is of special interest, for it shows the man as he is seen by his disciples and his co-workers. Professor Crocker was a pioneer and has been a leader in the great industrial and commercial development of electricity —which has so changed economic conditions in the United States during the last thirty years. He is one of the men who "do things"—who accomplish practical results from the application of scientific discoveries. And in this rare combination of genius and talent. Kelvin, as he points out, is one of the world's greatest masters. Professor Crocker does not make any effort to give a personal or a professional biography of Lord Kelvin, nor a summation of his work. Such data are readily available from many sources. His sketch displays something different—a personal impression of the individuality of the great scientific worker, and a brief interpretation of his peculiar powers of mind.—THE EDITORS.

TO write a complete biography of Lord Kelvin, one should possess at least a portion of his many-sided talents,—in fact, it would probably be necessary for a number of specialists to review his work, each from his own point of view. A full record of what he has accomplished in the electrical field alone would fill many volumes. I have had the honor and good fortune to meet this great man on many occasions, and particularly during his recent visit to the United States. A few notes regarding the impressions made by his personality and the lessons taught by his career may be appropriate and interesting at the present time.

In his case we have an excellent example of inherited ability; his father was professor of mathematics in the University of Glasgow, where the son subsequently rendered fifty years of most distinguished service. His brother, James Thomson, was professor of engineering and mechanics in the same seat of learning—a remarkable case of three members of one family occupying professional chairs in the same university and following closely similar lines of work. A striking point in Lord Kelvin's life is the fact that he began his public career with fully developed powers when he graduated from Cambridge as second wrangler and first Smith's prize man, being almost immediately appointed professor of natural philosophy in the University of Glasgow. The jubilee of his brilliant service there was celebrated a few years ago, the attendance including delegates from educational institutions and learned societies from all over the world, who came to testify their admiration for the scientific achievements of a great savant as well as their personal respect and esteem for the man.

The part played by Lord Kelvin in connection with the laying of the Atlantic cable is undoubtedly his strongest claim to high rank in the history of science and engineering. No other feat accomplished by human powers appeals more forcibly to the layman as well as to the specialist. Not only were mathematical knowledge and ability of the highest order required to solve the problems involved in this great undertaking; co-ordinated with these faculties the greatest possible degree of common sense and practical faculties were equally necessary. It is ordinarily supposed that these two phases of mind are opposed to each other, the development of one having a tendency to dwarf or diminish the other. In Lord Kelvin's case the two are combined and each is of the very highest order. It is in this particular respect that he is undoubtedly the greatest man of any time. On the purely scientific side, Helmholtz and other names might be mentioned as his equals; a number of electrical engineers and inventors, notably

Edison, have accomplished more individually in the way of actual mechanical achievement than he has; but no one else has done so much in both directions at the same time, and done it so well, as he. In abstract science, his mathematical investigations in mechanics, heat, electricity, and magnetism, are classical and will always remain fundamental in the progress of human knowledge. The numerous pieces of working apparatus invented by him will certainly remain prominent for a long time to come, if not perpetually. For example, the principles of his reflecting galvanometer, ampere balance, electrometers, siphon recorder, marine compass, and deep-sea sounding apparatus, would seem to be so general that they would always be useful—in fact necessary—even though improvements in construction and operation might be devised in the course of time. And the mere listing of their names suggests the breadth of the range of Lord Kelvin's accomplishments in the domain of applied science.

In the case of men of genius, personal qualities often detract from their intellectual achievements and seriously interfere with their popularity; but in Lord Kelvin's case the reverse is true to a remarkable degree. Anyone who has even heard him speak in public has been at once impressed and charmed by his mental and personal qualities. He combines the intellect of a great philosopher with the straightforwardness and simplicity of a schoolboy. He takes his audience into his confidence, and thinks aloud without the slightest affectation or self-consciousness. He regards the great things that he has accomplished as matters of fact, and accepts the credit and praise that is given to him without the least embarrassment or protest. When he speaks of his own work the language is most modest, and it is characteristic of him to name in the same breath others whom he credits with having contributed as much as or more than he has. There is no artfulness in this manner of referring to his great deeds; it is a natural—in fact, an unconscious—expression of his fairness and broad-mindedness. Another characteristic feature of his modesty is his habit of asking numerous questions of any one he meets, whether it be a learned scientist or a common workman—and his manner of addressing the one is as good-natured, polite, and interested, as when he speaks to the other.

His ideas and methods have always been marked with a high degree of originality. Whatever subject he has taken up, he has viewed from his own standpoint; and he has been free from the prejudices and narrowness that may have surrounded it. Indeed, if one were to criticize his work it would probably be on the ground

that originality had been carried too far, and, that some of his conceptions regarding the constitution of matter and of the universe in general were hardly warranted by the accepted facts of science. In other words, he is not confined by the academic methods of reasoning and conservatism in reaching conclusions. As an example of his radical views, I may quote his stated belief that the entire power of Niagara should be appropriated for the useful purposes of mankind, even at the sacrifice of the most beautiful and impressive sight on the face of the globe. He mentally pictures the rocks over which the waters now flow as covered with green grass. To him this is a more beautiful idea than the present grandeur of Niagara. The saving and distribution of four million horse power for the benefit of humanity is more to be desired than the mere scenic phenomenon which delights the eye and impresses the mind. His genius in this case undoubtedly enables him to see farther and more clearly than the ordinary person, and it is probable that the idea which now appears so radical will gradually become more and more general and that the world will be reconciled to it—unæsthetic and utilitarian as it may appear at the present time.

The profession of electrical engineering which now plays a prominent part in human affairs and numbers many followers, may justly claim Lord Kelvin as its father. Although telegraph lines had been laid on land by others, he was the first to undertake the application of electricity on a scale and of a character that could properly class it as a branch of engineering. It is a fact also that the type of men and the methods employed in electrical engineering have followed closely along the lines laid down by him. The application of accurate mathematical calculations and refined physical measurements to everyday practical problems is characteristic of his work as well as of this branch of technology. It is a most fortunate fact that a great leader possessing the genius and training was found when needed, so that correct conceptions and methods were introduced at the very beginning.

Wolverine Motor Boats in the Harbor of Bocas del Toro.

MOTIVE POWERS FOR THE MODERN LAUNCH.

By E. W. Roberts.

The application of powers other than steam to marine propulsion marks the beginning of an era of increased use of waterways, which will be not only of great importance to the general economy of transportation and distribution, but of immense ultimate advantage to the old-established agencies—the steamship and the railway. The general relations of water transport to traffic interests will be strikingly presented in a succeeding number of the Magazine. Mr. Roberts discusses the mechanical features, at a time when the great motor-boat exposition at Berlin is directing general attention to the importance of this comparatively new department of marine mechanical development.—THE EDITORS.

WHILE the steam engine has been a faithful servitor, and is so at the present, it has many drawbacks for the smaller craft in which the owner is usually his own engineer and helmsman as well. As owner of a small steam launch for several years, I can speak upon this subject from the heart. A suit of overalls was the most appropriate uniform, and even with anthracite coal the fire door was ever hungry and calling for more fuel, which it was necessary to feed to it in homeopathic doses by means of a stove shovel. Then there was the injector to watch, and a close balance to be kept between a fresh fire on the one hand and a new supply of water on the other, lest you lie to for steam to come up, since small launch boilers are frequently none too large for their engines. True, there was the alternative of a kerosene-oil burner, with its delightful (?) odor but with many drawbacks. And as if these troubles alone were not enough, there came the many repairs in the shape of fixing leaky flues, and the worry of keeping up steam when a little stream of water was oozing down into the fire box, or the fun of paddling to shore with a seat or a piece of flooring when a hand-hole gasket blew out. In

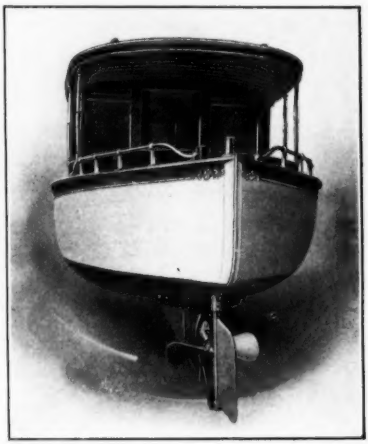
THE LOZIER LAUNCH FAN TAN.
Running on Lakes St. Clair and Erie. 31 feet long, 6 horse power, speed 9 miles per hour; torpedo stern.

fact, I could continue this tale of woe several pages. Other powers do have their troubles, but they are few in comparison with the small steam launch, especially in the hands of the novice.

Yet until less than two decades ago the steam engine was practically the only available power for small launches, but within the past twenty years there have sprung up several methods of propulsion that are much better adapted to the needs of the smaller craft, and one at least of them has encroached to a considerable extent on the steam engine for business boats. These are the vapor, the gasoline, and the kerosene engine, and the electric motor. The vapor engine and the gasoline engine both came into use about the same time or in the latter part of the eighties; the electric launch saw its first practical introduction at the Chicago exposition in 1893; and the kerosene marine engine has been introduced only within the past decade.

In order to distinguish readily between the various classes of motive power, a short description of the principles of operation of each will be given. Of course there is little danger of confusion of the electric motor with the other powers, but there has, in the past, been considerable misunderstanding about the difference between the gasoline engine and the vapor engine.

The vapor engine, which finds its principal examples in the "Only Naphtha" and the "Alco Vapor" engines, is sim-

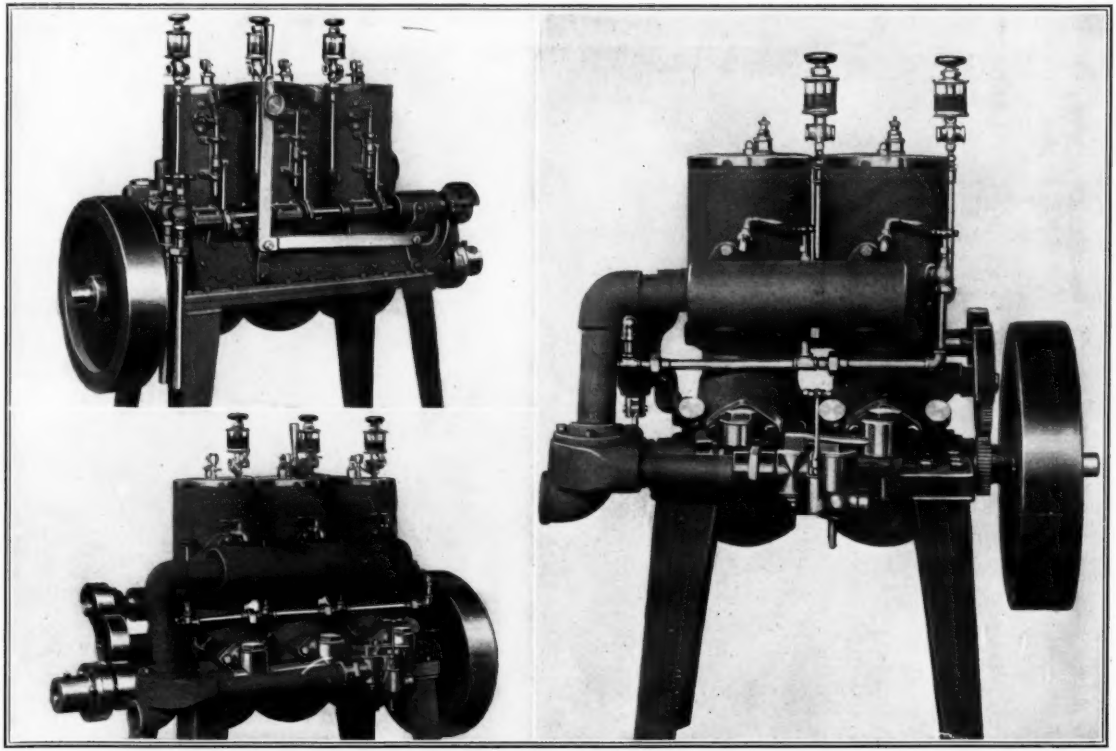


"TORPEDO STERN," TO PREVENT SETTLING AND DRAG.
Lozier Motor Co., Plattsburg, N. Y.

ply a pressure engine, similar in its general principles to a steam engine, but in which the vapor of the more volatile liquids is employed instead of steam. In the "Only Naphtha" engine gasoline is the liquid that is thus employed. The heat beneath the boiler is generated by means of a portion of the vapor from the boiler which flows to the burner. The remainder passes to the engine furnishing the motive power, and thence to the condenser, whence it is pumped back into the boiler. In the "Alco" engine, power is furnished by the evaporation of alcohol, with gasoline as the fuel, there being of course no connection in this case between the boiler and burner.

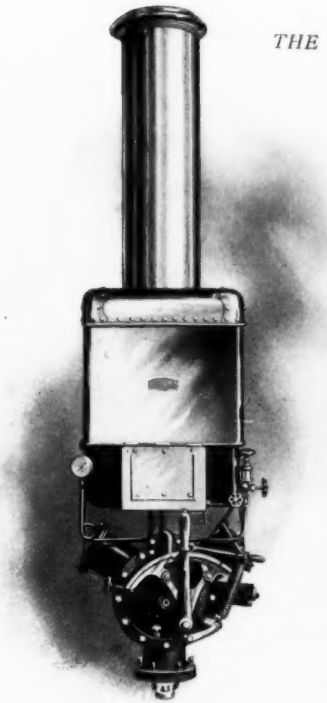
LAUNCH RAJAH, ON ST. REGIS LAKE, ADIRONDACK MOUNTAINS, N. Y.
31 feet long, torpedo-stern model, speed 9 miles. Lozier Motor Co., Plattsburg, N. Y.

The gasoline and the kerosene engine are each types of the internal-combustion engine of which the gas engine is the parent. Their general form is the same, the only difference between them being the means for vaporising the fuel and in some cases of igniting it. The principles of operation are alike in both cases. The modern form of gas engine employs a series or cycle of operations invented by Beau de Rochas in 1870 and put into practical form by Dr. N. August Otto in 1876. It was long known as the "Otto" cycle, but later writers on the subject usually call it by the name of its originator. Owing to the fact that four strokes of the piston are required to complete the



ON THE LEFT ABOVE IS FORWARD PORT VIEW, AND BELOW IT REAR STARBOARD VIEW, OF A TRUSCOTT THREE-CYLINDER TWO-CYCLE SELF-STARTING AND REVERSING VAPOR MARINE MOTOR; ON THE RIGHT IS A STARBOARD VIEW OF A TWO-CYLINDER TWO-CYCLE MOTOR OF THE SAME MAKE.

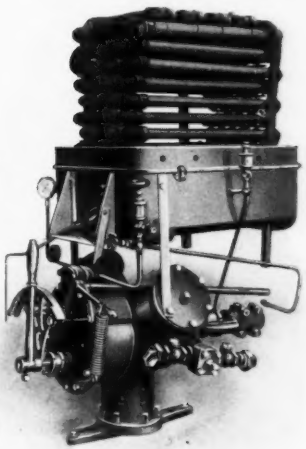
Truscott Boat Manufacturing Company, St. Joseph, Mich.



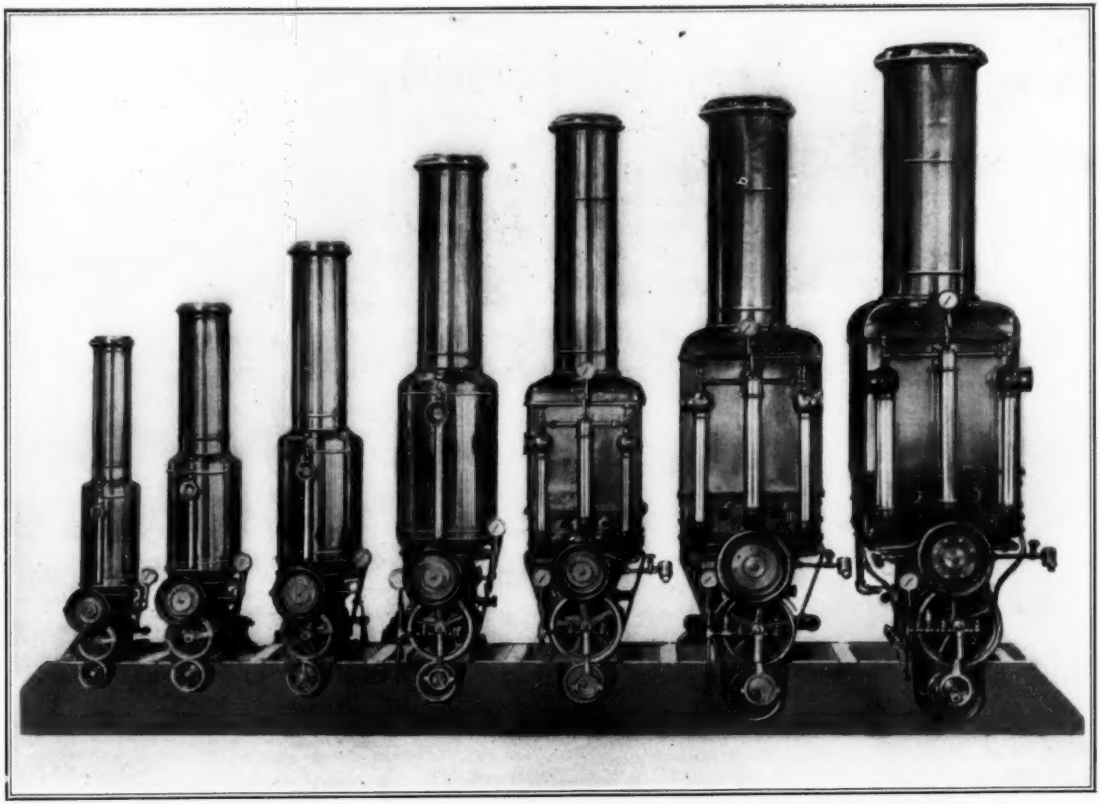
ALCO-VAPOR 7-HORSE-POWER RETORT AND ENGINE.
Marine Engine & Machine Co., Harrison, N .J.

through the inlet valve. Just as this stroke is completed, the inlet valve closes, and, the charge being confined, the return of the piston compresses it into a space between the end of the piston travel and the cylinder head. A little before the end of this stroke is reached, the compressed charge is ignited, usually by means of an electric spark, and the cycle, it is often called "four-cycle" engine. This latter term, however, is used principally to distinguish it from a later modification in which the series of operations is completed in two strokes of the piston, and the latter form is therefore called "two-cycle" engine.

The series of operations which takes place in the four-cycle engine is as follows: Suppose the engine to be a vertical one, as that is the form quite generally employed for marine purposes. On the first down-stroke of the piston a charge of fuel and air is drawn into the cylinder



VIEW OF ALCO-VAPOR RETORT WITH JACKET REMOVED.

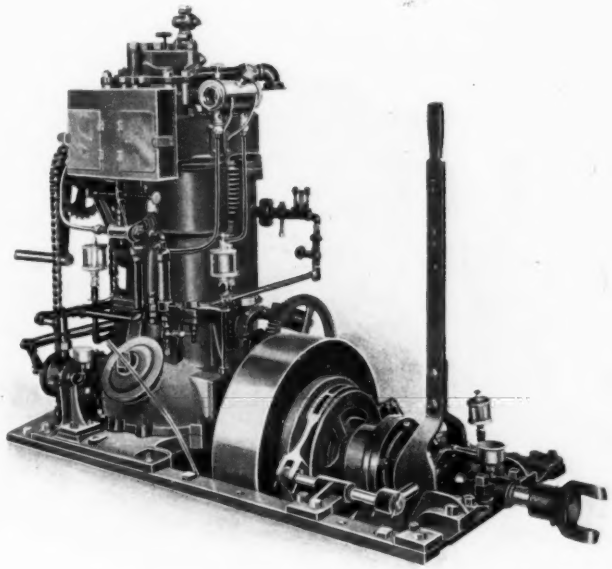


A GROUP OF NAPHTHA-VAPOR ENGINES FROM 1 TO 16 HORSE POWER.

Gas Engine and Power Co. and Charles L. Seabury & Co., Consolidated, Morris Heights, N. Y.

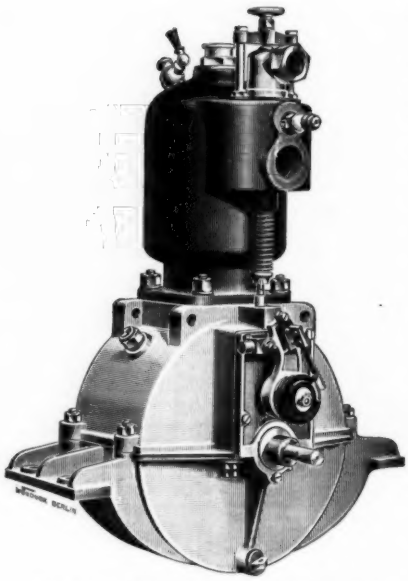
sequent generation of heat due to the combustion of the fuel causes a sudden rise of pressure which amounts to an explosion. The ignition is usually so timed that the maximum pressure is reached just as the piston starts on its downward stroke.

During the succeeding downward stroke, the products of combustion expand, driving the piston and giving the power to the engine. When the piston has reached nearly the end of the expansion stroke the exhaust valve opens, and the pressure within the cylinder rapidly falls to that of the atmosphere, which it has practically reached when the expansion stroke is completed. The cylinder is cleared during the next up-stroke of the piston, and the following stroke begins the cycle once more by drawing in a charge of fuel and air.



DAIMLER 7- AND 12-HORSE-POWER MARINE MOTOR. PORT SIDE.

In the two-cycle engine the exhaust stroke and the suction stroke are eliminated by drawing the charge into a chamber enclosing the crank, and called the crank case. On the up-stroke of the piston a vacuum is formed in the crank case, drawing in a charge of fuel and air, which on the next down-stroke is compressed to about two to six

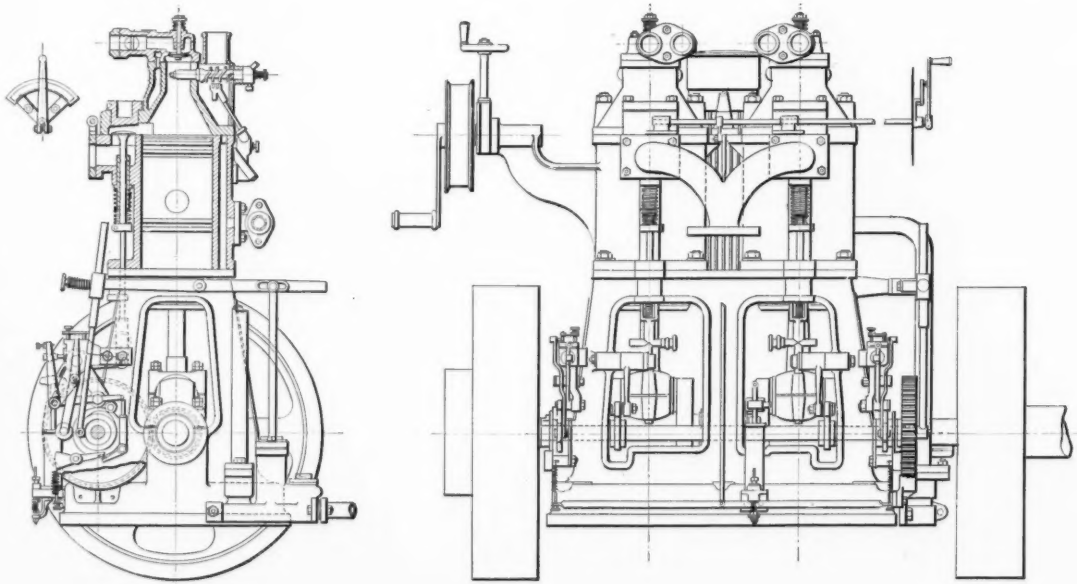


SINGLE-CYLINDER BENZINE OR PETROLEUM-SPIRIT MOTOR.

Heinrich Kämper, Berlin. Made in sizes from 3 to 7 horse power.

pounds per square inch. When the piston is nearly at the bottom of its stroke, it uncovers a port leading to the crank case and the slightly compressed charge rushes into the cylinder. Compression and expansion follow, and just before the port to the crank is opened, a port on the opposite side of the cylinder is uncovered through which the exhaust gases escape, and the fresh charge entering the cylinder is deflected toward the head by a plate on the piston and drives out the balance of the exhaust. The engine is therefore valveless and receives an impulse at each revolution.

For the purposes of the marine engine it is apparent that gas, unless manufactured as required, is out of the question. Even the manufacture of gas on shipboard would have many objectionable features. Fortunately the abundance of liquid fuel suitable for the operation of the gas engine makes the employment of a gas producer unnecessary. By the means of a very simple device the liquid fuels may be vaporized as used, and beyond a tank in which to store the fuel, no apparatus outside of the engine and a source of current for the igniter is required. Of the liquid fuels available for the operation of gas engines, or more strictly, internal-combustion engines, the following have been employed:—Gasoline, kerosene, distillate, alcohol, cocoanut oil and mustard oil. Distillate is a product of petroleum a little denser than gasoline, while not of as great specific gravity as kerosene. Alcohol has not, to my knowledge, been employed to any extent for the operation of gas engines in marine work, although it is being extensively experimented with in France for automobiles. Cocoanut oil and mustard oil would seem to a resident of the United States



SECTION OF A TWO-CYLINDER PETROLEUM MARINE MOTOR BY THE MASCHINENBAU-ACTIENGESELLSCHAFT, FORMERLY PH. SWIDERSKI, LEIPZIG-PLAGWITZ, GERMANY.

Made in sizes from 6 to 30 horse power, lower powers being furnished in single-cylinder machines.

36-FOOT ELECTRIC CABIN LAUNCH.
Speed 8 miles per hour. Operated on Hudson River and New York Bay. Electric Launch Co., Bayonne, N. J.

to be somewhat expensive fuels for a gas engine. They are, however, employed for this purpose in India where they are used on the score of economy. Probably nothing has been done with them in marine engines.

The electric launch needs very little explanation, as the electric motor is familiar to all of us. As in the electric automobile, current is furnished to the motor by a storage battery. Batteries of primary cells have been tried and even placed upon the market, but have proven more troublesome than otherwise.

The vapor engine appeals to those familiar with the steam engine, owing to the similarity of its operation. It is practically automatic in its action, after once started, and takes up considerably less space than a steam plant of the same power. Quite a number of these engines are in use, especially for pleasure craft.

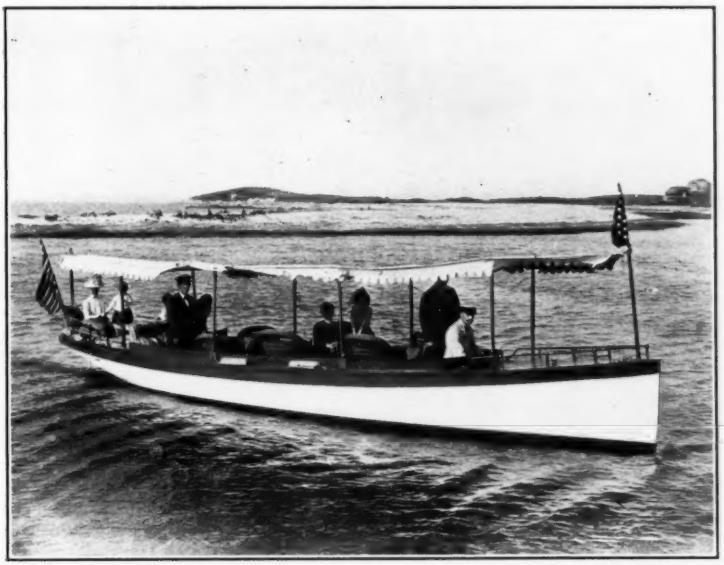
The gasoline engine is quite popular, particularly when operated with electric ignition as the majority of these engines are, since there is no flame outside of the engine. A gasoline engine using an electric igniter may be deluged with the fuel without fire resulting. The method of operating it is easily mastered, and no preparation is required to start the engine beyond turning on the fuel and closing the igniter switch. The fuel can usually be obtained anywhere, as it is quite generally carried in stock by grocerymen for gasoline stoves.

The kerosene engine is popular among many owing to generally exaggerated ideas about the "dangerous" nature of gasoline, and also

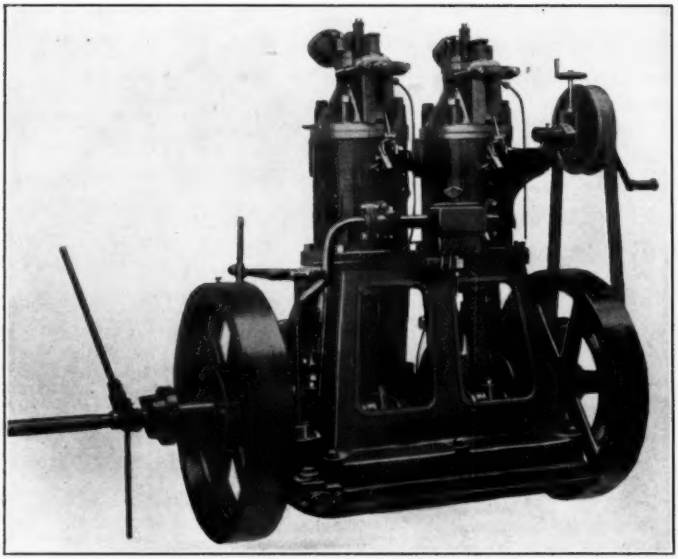
to the great difference in the price of the two fuels in many localities. The widespread use of kerosene as an illuminant also makes it more readily obtainable than gasoline, which is probably one of the greatest arguments in favor of the kerosene engine. Usually, however, it is necessary to heat the vaporizer of a kerosene engine before it can be started, and it is not so quickly got under way for this reason.

The distillate engine is quite generally employed on the Pacific Coast owing to the large quantity of that fuel that is made as a by-product from California petroleum. As with the kerosene engine, the vaporizer must be heated before the engine can be started, although not so high a temperature is necessary as with a kerosene engine.

Of all the small-power boats, the electric launch probably approaches nearest to the ideal. Both the battery and the motor may be, and usually are, placed out of sight beneath the seats and the floor of the boat. So long as the battery is charged the boat is ready to start at the touch of a lever, and the motor is silent and cleanly. No reversing mechanism is necessary, and no odor is produced beyond the slight fumes of the acid which are scarcely noticeable in the open air. However, the electric launch is dependent upon an external source

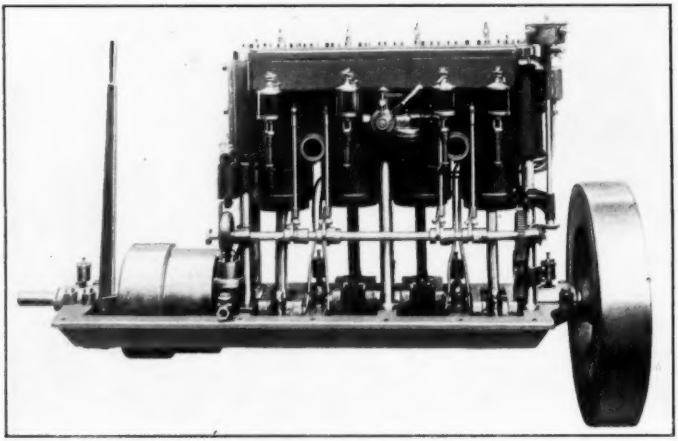


30-FOOT ELECTRIC LAUNCH ON LONG ISLAND SOUND.
Speed 7½ miles per hour. Electric Launch Co.



TOLCH DOUBLE-CYLINDER 10-HORSE-POWER MARINE OIL ENGINE.

Tolch & Co., Fulham, London.



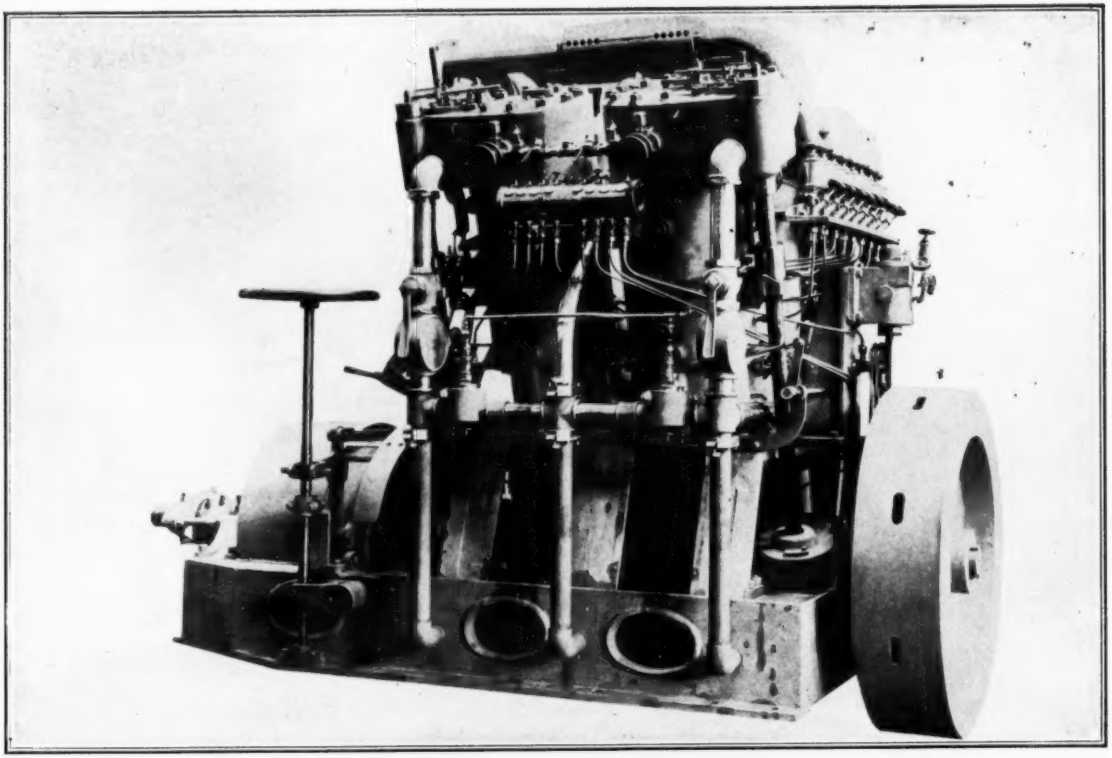
KING 30-HORSE-POWER MARINE ENGINE.

Four-cylinder four-cycle, weight 2,300 pounds. Michigan Yacht and Power Co., Detroit, Mich.

of power and unlike the gasoline engine, which can be replenished with fuel in a moment, several hours are required for recharging the battery of the electric launch. Again, its radius of operation is confined, and long trips without lying to for recharging are out of the question. Yet for many purposes these objections are not important, and the electric launch has a wide field of usefulness.

GASOLINE ENGINE BOAT BY HEINRICH KÄMPER, BERLIN.

Of all marine powers other than steam, the gasoline engine is without question that most used. It will be found on the majority of the waters of the world. The history of the gasoline marine engine dates from 1885. It was in this year that the first successful gasoline engine for any purpose was placed upon the market. The earliest attempts at using gasoline for an internal-combustion engine were made about the same time by Van Duzen Brothers in Cincinnati and the

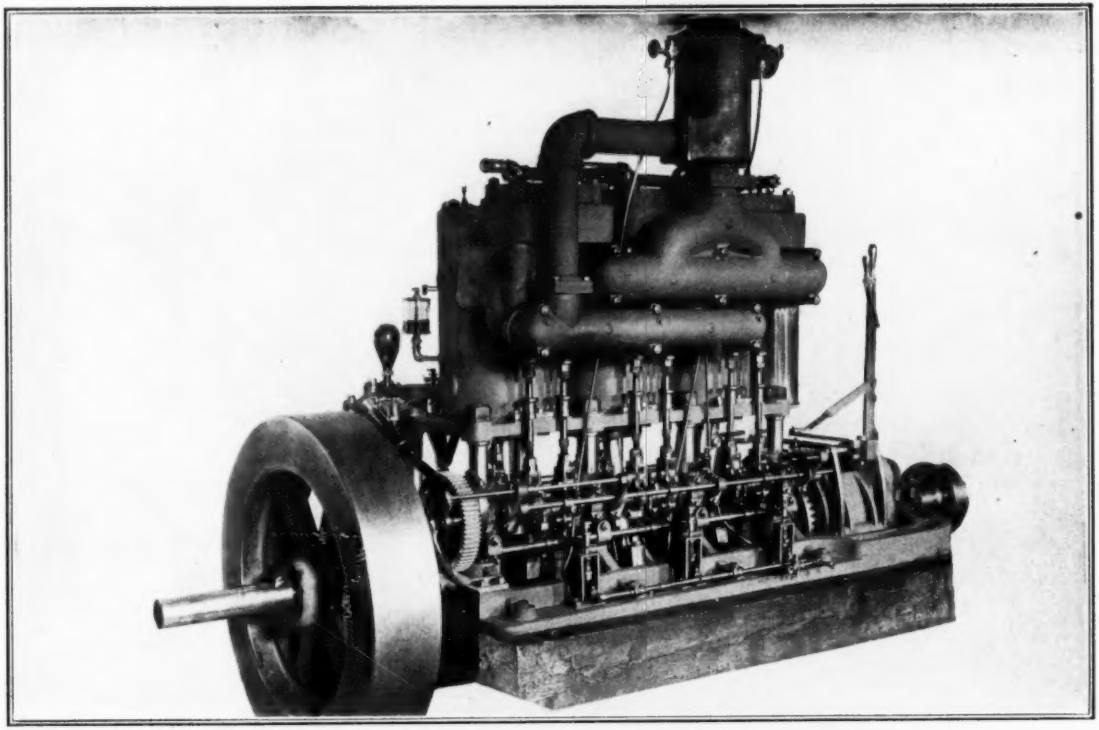


85-HORSE-POWER FOUR-CYLINDER FOUR-CYCLE ENGINE.
Union Gas Engine Company, San Francisco, Cal.

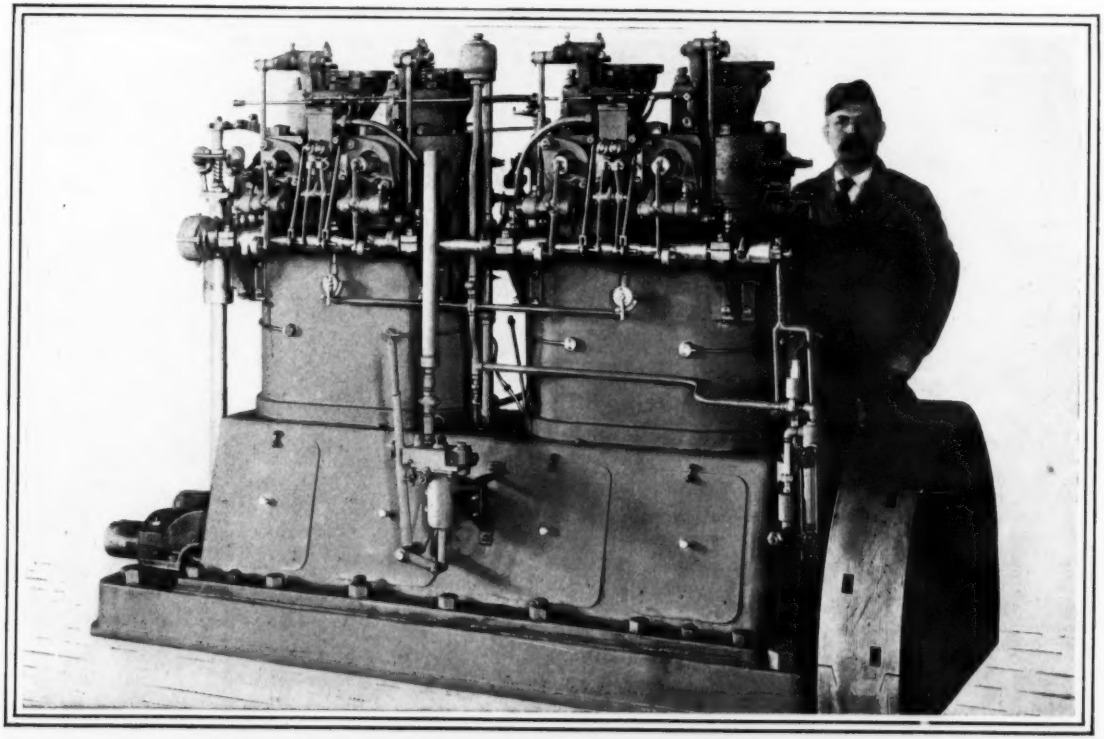
Union Gas Engine Company in San Francisco. The first attempts were fraught with many difficulties, owing to a misunderstanding of the fuel and of its behavior when mixed with air. At that time the most cumbersome and inefficient devices were employed for supplying the engine with gasoline vapor, while today a simple valve, scarcely more complicated than the ordinary check, is employed for this purpose. The industry remained practically in the cradle until the early nineties, but by the time of the Chicago Exposition quite a number of small gasoline marine engines were in use. After that time their introduction was rapid, and there is scarcely anywhere to be seen today an assemblage of pleasure craft in which the gasoline launch is not very much in evidence. From the 12-foot dingy with its one-horse-power engine to the 92-foot yacht with its 133-horse-power engine, the range of this class of power is even now considerable. The largest marine gasoline engine that has been brought to my notice is that furnished by the Otto Gas Engine Works of Philadelphia to The Holland Torpedo Boat Company for one of their latest submarine torpedo boats. This engine, which is illustrated herewith, developed 190 brake horse power at a speed of 360 revolutions per minute.

The tendency of all builders of gasoline marine engines is toward larger powers than heretofore. While for the smaller sizes the two-cycle engine has been employed to a greater extent than the four-cycle, the larger engines of the marine type are invariably four-cycle. The tendency toward the four-cycle engine for the larger sizes is shown by the fact that many builders of two-cycle engines choose the earlier type when they exceed 25 horse power in a single engine. As an example, note the illustration of the latest product of the Wolverine Motor works, an 85-horse-power engine of the four-cycle type. This concern has been building two-cycle engines for a number of years. The reason for this would scarcely be obvious to those unfamiliar with gas engineering. It is principally a choice between simplicity of mechanism and economy of fuel. The difference in fuel consumption is scarcely noticeable in the smaller sizes, and the extreme simplicity of the two-cycle engine makes it a favorite for the owner of the smaller craft. However, when 30 horse power is passed fuel consumption has a marked effect upon the operative radius and also upon the expense account.

Contrary to the usual opinion, the question of weight per horse power is not to the advantage of the two-cycle engine. If anything, the advantage is slightly in favor of the four-cycle. This is because it is not necessary to enclose the cranks on a four-cycle engine, while



WOLVERINE 85-HORSE-POWER THREE-CYLINDER FOUR-CYCLE MARINE ENGINE.
Wolverine Motor Works, Grand Rapids, Mich.



FOUR-CYLINDER ENGINE OF 190 HORSE POWER FOR SUBMARINE TORPEDO BOAT.
Otto Gas E..gine Works, Philadelphia, Pa.

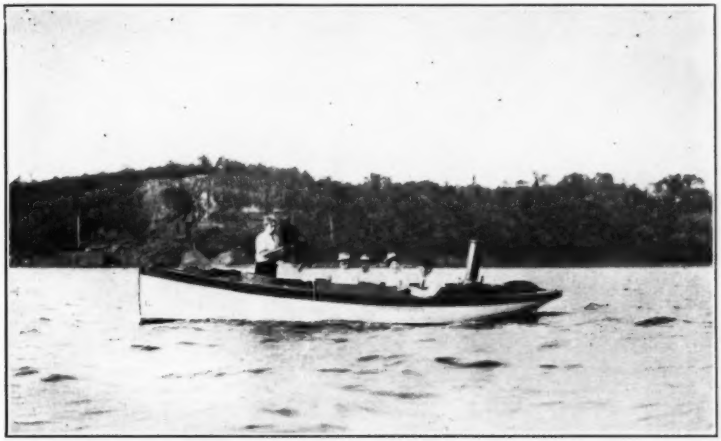
on the two-cycle, the crank must not only be enclosed but the crank case must be strong enough to withstand a low-pressure explosion.

The kerosene marine engine, while but lately introduced and therefore not yet subjected to an extensive trial, is quite likely to become an extensive factor in the launch trade. While I have had no personal experience with marine engines operated by this fuel, I have seen many stationary kerosene engines which gave excellent satisfaction. However

60-FOOT 16-HORSE-POWER CABIN NAPHTHA YACHT REGINA.
Gas Engine & Power Co. and Chas. L. Seabury & Co. Consolidated, Morris Heights, N. Y.

from experiments I have made, and which I am not at present at liberty to discuss, I have found that kerosene is not so difficult to handle in an internal-combustion engine as many suppose. In fact, but little more apparatus is required to handle this heavier fuel that when gasoline is employed.

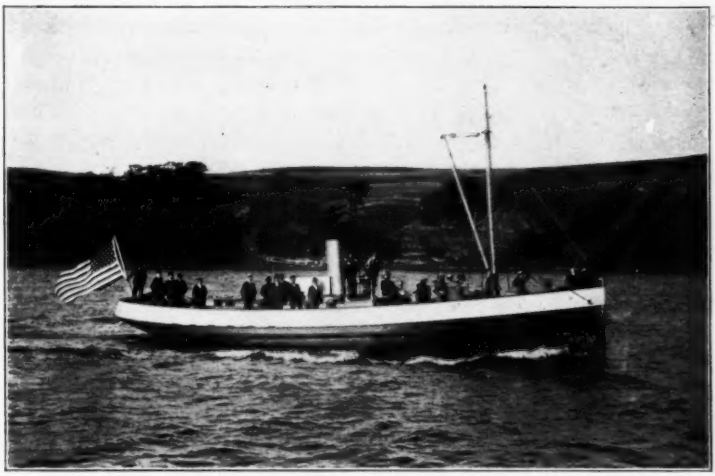
The adaptability of the gasoline marine engine to special environments can be no better illustrated than by citing the conditions in



25-FOOT 4-HORSE-POWER OPEN NAPHTHA LAUNCH.

Gas Engine & Power Co. and Chas. L. Seabury & Co., Consolidated, Morris Heights, N. Y.

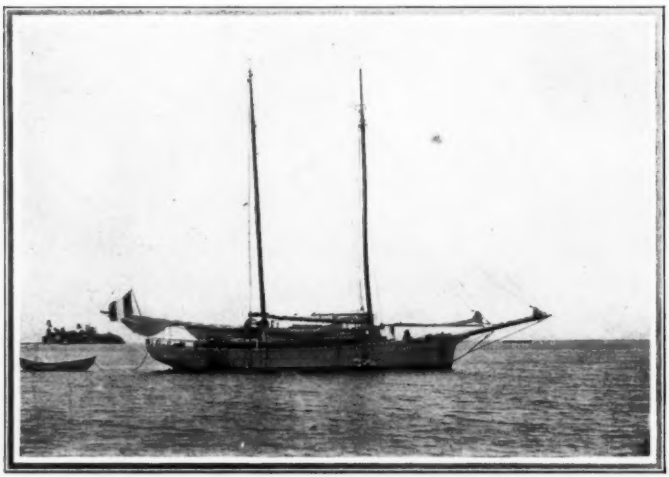
Bocas del Toro, United States of Colombia. This town is surrounded by a number of bays and lagoons which are lined with banana plantations. No fresh water is available except that which is caught on the



LAUNCH UTA, HARBOR BOARD OF WELLINGTON, N. Z.

64 feet long, 14 feet beam, speed 9 knots, 50-horse-power double-cylinder vapor engines, 4-horse-power windlass, 3½-horse-power stationary vertical engine for electric light.

Union Gas Engine Co., San Francisco.



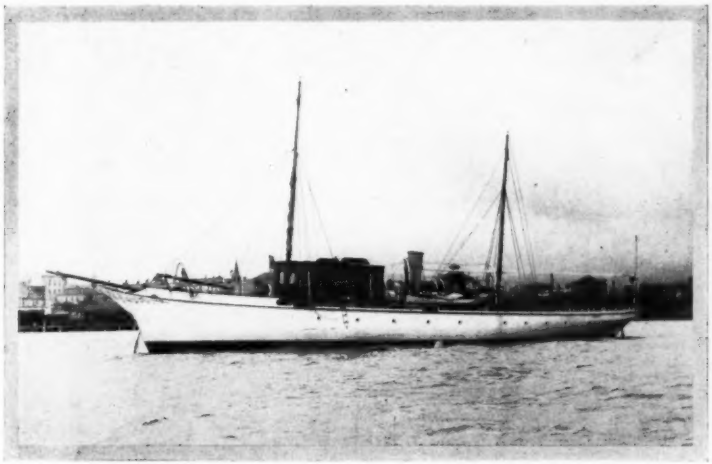
YACHT LA PERLE; PROPERTY OF THE FRENCH GOVERNMENT AT TAHITI.
40-horse-power vapor engines. Union Gas Engine Co.

roofs of the houses, and salt water being ruinous to steam boilers a steam launch may be operated for only a short time without being laid up for repairs. About eight years ago two gasoline engines were introduced, and they proved themselves to be so well-adapted to the conditions that at present there are over forty gasoline launches employed, as tugboats for towing banana lighters to central points where the fruit is transferred to ocean steamships. An enterprising planter secured an expert from one of the American factories and installed a complete repair shop especially adapted to gasoline engines. These tugboats are employed going from plantation to plantation gathering up the fruit, which, on account of its perishable nature, must be transferred in the shortest possible time to the ships. There are at present thirty-five of one make of gasoline engine in use in this district. The gasoline is shipped to the tug owners in 210-gallon drums, and the small space occupied in transport is especially in its favor as a fuel since there is no coal obtainable in the market and all of it must be shipped from the United States.

Another place in which the gasoline engine has proven itself to be the only available power is in the life-boat service. The United States Government has in use a life boat propelled by a gasoline engine. This boat may be upset any number of times and the engine be ready to start again as soon as the boat is righted, the engine being

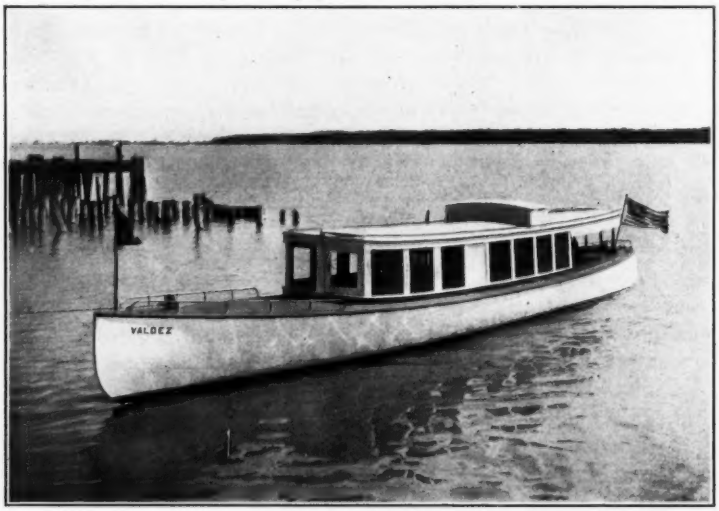
stopped automatically when the boat is capsized. The boat has been in use for a little over two years at a station near West Superior, Wisconsin.

On the Pacific coast and about many of the islands off the western American coasts may be found numberless craft operated by gasoline engines, most of which are manufactured in San Francisco. Many of these vessels are engaged in the coast trade, and a good many are converted steamers. Quite a number of sailing vessels are equipped with gasoline engines as auxiliaries and are thus independent to a certain extent of the weather and entirely independent of tugs when entering a harbor. The various Governments which have colonies in the Pacific islands use gasoline launches and tugs for various purposes. On the coast of Eastern Australia they are found everywhere, and even on the waters about Tasmania, while the New Zealanders are adopting them and have many in use. A few gasoline marine engines have been sold in Western Australia, where I expect to see them finally introduced in great numbers. Even on the Yukon river in Alaska gasoline launches have been in use for at least two years, and perhaps nothing was so thrilling to me as the story of the little launch Melrose which so successfully shot the White Horse Rapids in the summer of 1900. Last season the builders of the Melrose shipped another and larger boat, the Valdez, to the same district. The Valdez was shipped by



YACHT LUCERO, CONVERTED FROM STEAM TO GASOLINE ENGINES.
92 feet long, 16 feet beam; four-cylinder four-cycle engine of 133 brake horse power. Union Gas Engine Co.

rail to Seattle and thence made the run of 1,700 miles up the Pacific coast to the gold fields. Quite as remarkable a trip was that of the gasoline launch Zeta, owned in New Orleans. Starting from home the journey was up the Mississippi River, thence by Canal to Chicago and the Great Lakes, finally arriving at New York City and returning by the inside course and around the coast of Florida to New Orleans. Not only was this trip an enjoyable one because of its extent and the



THE YACHT VALDEZ.

52 feet by 9 feet, 20-horse-power Sintz engine; Michigan Yacht & Power Co., Detroit, Mich.

scenes through which it passed, but it was unmarred by mishap of any kind.

Not only is the gasoline launch adapted to long trips and hard service, but in matters of speed as compared with other boats of the same size and horse power of engine it is quite equal to any. Only last summer I tested the Caprice, a 42-footer built for a gentleman residing in Pittsburg for use on the Muskoka lakes in Canada. Four days after this boat was launched, and while the engine was still new and stiff in its bearings, it made an actual speed of 12.8 miles per hour. Better than 13 miles per hour has since been obtained from the same boat. The tests referred to were made in quiet water with a carefully calibrated log and on a perfectly calm day. The engine used was a two-cycle, rated at 20 horse power but capable of developing 30 horse power at the speed used in the test.

YACHT CAPRICE—20 HORSE POWER, 13 MILES PER HOUR.
Sintz engines, Michigan Yacht & Power Co.

The small amount of room required for a gasoline engine and the fact that the fuel tank may be placed in any position, either under the forward or the after deck or under the floor, makes this style of boat much more roomy for length and beam than a steam launch, with its boiler and large coal bunkers. The absence of smoke and heat is also a considerable factor and adds greatly to the comfort of a trip.

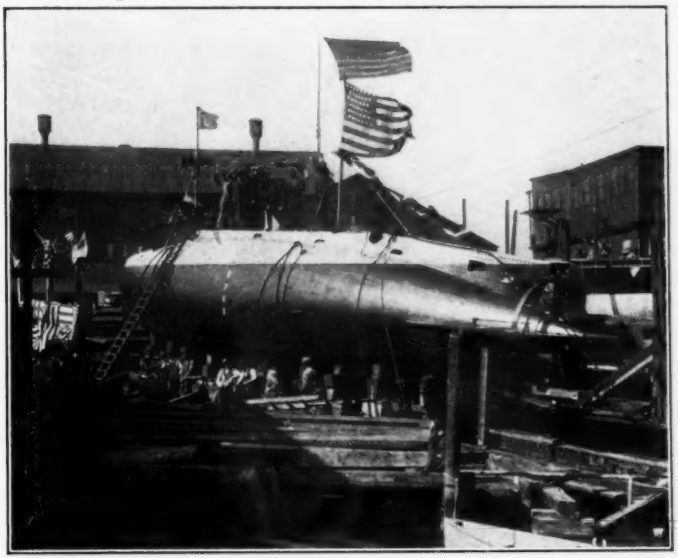
The great number of the manufacturers now making gasoline marine engines has been the occasion of considerable competition and a striving for improvements which now make the gasoline engine as

YACHT 53 BY 10 FEET, 18-HORSE-POWER THREE-CYLINDER SELF-STARTING AND REVERSING ENGINE.
Truscott Boat Manufacturing Co., St. Joseph, Mich.

17-FOOT "TORPEDO-STERN" LAUNCH, 1½-HORSE-POWER.
Truscott Boat Manufacturing Co.

YACHT HELEN, 60 FEET BY 9½ FEET, SPEED 13½ MILES PER HOUR.
Two 20-horse-power two-cylinder two-cycle Sintz vapor engines. Michigan Yacht & Power Co.

reliable as a steam engine. One manufacturer, at least, makes an engine that may be reversed, and practically every builder of gasoline engines of over 20 horse power supplies a method of starting them without manual labor. Where the engine itself is not reversible, an attachment is furnished with the engine to reverse the propeller, or else the propeller itself is so constructed that the angle of the blades may be altered, thus changing it from a right-hand to a left-hand screw and vice versa. The reversing propeller is seldom used for engines of over 6 horse power, as it is not so efficient as a solid wheel. But for

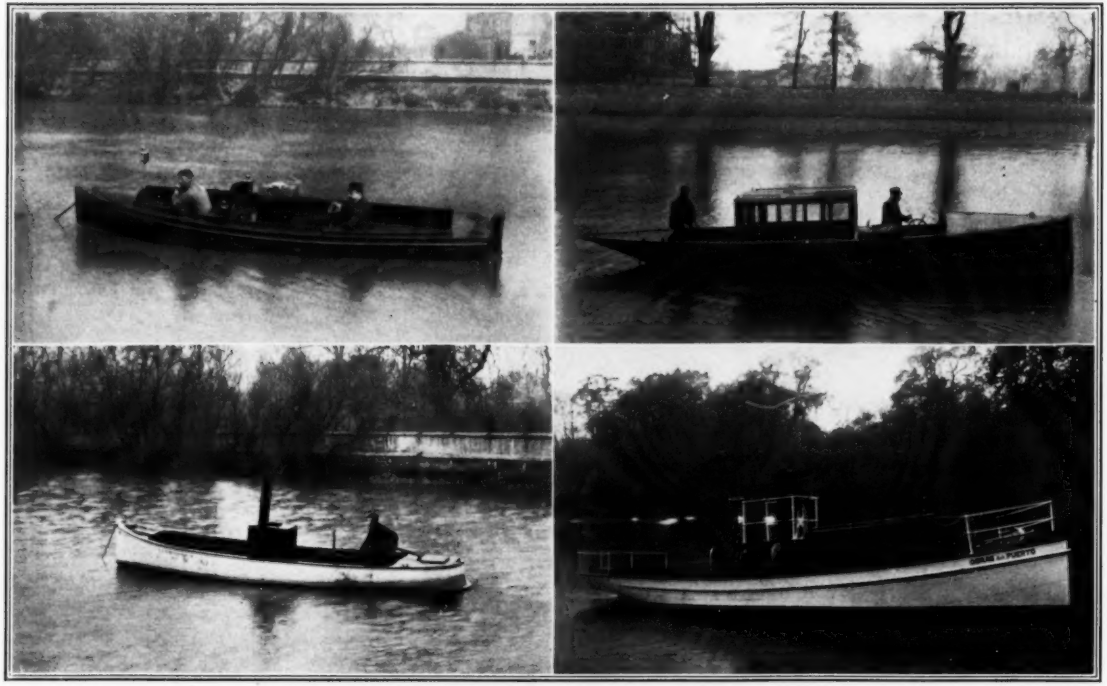


HOLLAND SUBMARINE TORPEDO BOAT READY FOR LAUNCHING, CRESCENT SHIPYARD, ELIZABETHPORT, N. J.

Propelled by electric storage battery (Electric Boat Co.) when submerged and by Otto gasoline engines when running on the surface.

small boats, in which the amount of room that would be taken up by a reversing gear would materially reduce the available space, the reversible propeller is exceedingly well-adapted.

The reversible engine referred to in the last paragraph is of the two-cycle type, and the change of direction is accomplished by slowing the engine down until it has nearly stopped, and then giving it an extremely early ignition which stops the piston and drives it backward; the throttle is then opened and the engine continues to run backward until again reversed. Starting devices as employed for marine engines



A GROUP OF OIL-MOTOR BOATS BY TOLCH & CO., FULHAM, LONDON.

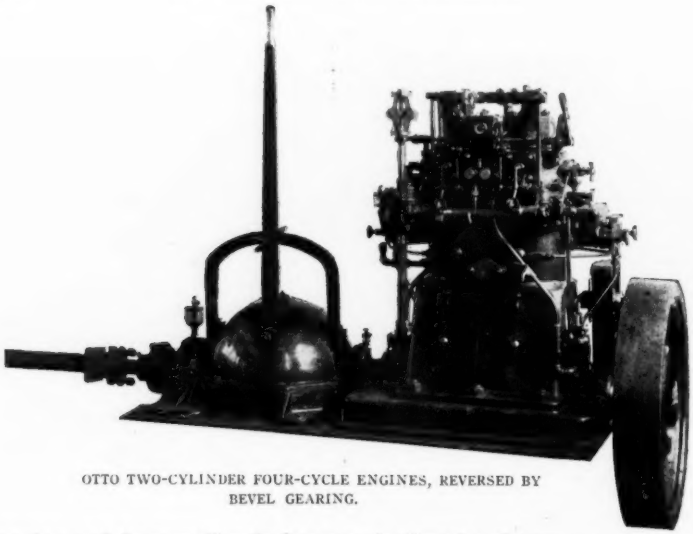
Above on the left is a 20-foot captain's gig, speed 7 miles; below it is a shallow-draught steel launch, 25 by 5¼ feet, 14 inches draught, running 7 miles an hour and powerful as a tug; the upper right-hand picture shows a 35-foot teak cruiser, with portable mast and sails; propeller blades feather in line with the keel when the boat is under canvas; in the lower right hand corner is a 40-foot steel launch with powerful engines, speed 10 miles an hour, controlled single-handed from the bridge above the engines; has also a mast and sail.

are of various kinds. In many an air pump geared to the propeller shaft is employed to keep full a reservoir of air at from 40 to 100 pounds pressure. The air is piped to the compression space of the engine and passes through an ordinary plug cock just outside the cylinder. To start the engine by compressed air the flywheel is turned over until the piston of one cylinder is just past the top of its stroke. The cock on that cylinder is then opened full and the pressure of the air drives the piston downward. The air is cut off before the piston reaches the end of its stroke and sufficient momentum is usually derived from this one impulse of the air to permit the engine to take up its cycle. In other engines a charge of gasoline vapor and air is pumped

INTERIOR OF THE HOLLAND SUBMARINE BOAT.

into the compression space with the piston on the upper center. The flywheel is then turned until the pressure of the charge just starts to move the piston, when the charge is ignited and the resulting explosion gives sufficient momentum to start the engine on its first cycle.

Reversing mechanisms, or as they are more generally known, reversing gears, are usually a combination of two bevel gears and pinions similar to the differential gear on automobiles and traction engines. When the engine is driving the boat ahead a clutch fastens both the large bevel gears together and the driving is direct and noiseless. When reversing, the pinions between the two large bevel gears turn on their own axes only, being held by a clutch from rotating with the



OTTO TWO-CYLINDER FOUR-CYCLE ENGINES, REVERSED BY BEVEL GEARING.

engine, and the propeller shaft rotates in direction the reverse of that of the engine. Other builders use a combination of spur gears, while still others employ paper friction cones.

Further improvements are the use of universal joints in the propeller shaft, thus permitting the engine to be placed with the crankshaft horizontal and not inclined toward the stern. The use of jump-spark ignition, as on automobile engines, was adopted by one manufacturer last season, giving greater flexibility in regard to speed. The problem of lubrication has been satisfactorily solved by the combined efforts of the manufacturer and the oil refiner, and the many minor difficulties have been surmounted until now the gasoline engine is in every way an ideal motive power.

A COMPARISON OF COAL RESOURCES AND COAL-GETTING.

By A. S. E. Ackermann.

Mr. Ackermann recently completed a tour extending over 5,000 miles in the United States and occupying four months, chiefly for the purpose of studying American methods of mining by machinery. In the following article he compares the methods of coal getting in Great Britain and the United States.—The Editors.

THE very first feature that attracts the attention of the European visitor is the enormous difference in the total area of the coal fields of America and Great Britain, namely 222,500 and 9,000 square miles respectively, and also the fact that nearly all the British ones have been worked for so very much longer a period. The result of this is that most of the thick seams and those nearest the surface have been worked out; and while 10-foot and 12-foot seams are not unknown, nevertheless they are exceptional, and seams as small as 12 and 15 inches are being worked. In America, on the other hand, the coal fields are practically untouched. At present only the thick and upper seams are being worked, and these to a large extent with perhaps little thought for future generations of mining engineers. Another very great difference between the coal fields of the two countries is that in Great Britain faults are frequent and great, and the coal is found in various parts at almost all conceivable angles. In the Lancashire coal field, for example, the seams dip 17 to 33 per cent. In America, on the other hand, I did not meet with a single instance of a fault, and only with one man who said he had a friend who had seen one, while the greatest dip I met with was but about 5 per cent.

In Great Britain the coal lies at very great depths. In America a shaft of 200 feet is considered fairly deep while one of 200 yards in England is but a shallow pit, and same few workings are nearly 4,000 feet deep. I do not know of a drift mine being worked at present in England, but in America, especially in Virginia and West Virginia, they are extremely common. The result of this is that the cost of hauling the coal out and the pumping of large quantities of water from great depths make coal mining very expensive in Great Britain. A drift mine is also more cheaply ventilated than a shaft one, and the mines

are much more fiery in England than they are in America. The presence of fire damp in British mines greatly impedes the rapidity of working and adds to the cost in many ways. There are many stringent regulations to be carried out with a view to the prevention of explosions, which nevertheless occur only too frequently, and when they do they are usually of a very serious nature, causing large loss of life and property. Frequently several months elapse before the mines are in complete working order again after such an accident. The cost of this loss of life and property naturally is very great.

The presence of combustible gas in the British mines further makes the employment of electrical machines of all kinds either impossible or very difficult, whereas in America the tendency seems to be to discard pneumatic machinery and use electrical, for cutting, hauling, pumping, and lighting; but in Great Britain even pneumatic machinery is but very little used, and in 1900 the total quantity of coal cut by machinery was only 1½ per cent. of the total output of the whole country, whereas the corresponding figure for the same period for America was 20 per cent., or 25 per cent., if bituminous coal alone is considered. The output per annum per person employed in coal mining in Great Britain is about 300 tons, compared with 526 tons in America, this difference of course being due to a large number of factors of which the natural conditions, as already indicated, are an important one. From a British point of view, however, it is significant that in spite of the much easier natural conditions that hold in the United States, machinery is being used there to such a very great and increasing extent, whereas in England, where natural conditions are more difficult and make coal getting more arduous, and hence where machinery ought to be made to lighten the burden of man, far less machinery is used, and I feel sure that were coal getting as easy in Britain as it is in America, machinery would be practically unknown in the British coal mines. On the other hand, American mining engineers were equally candid in telling me that they considered British mining engineers were much more successful in the handling of shaft mines than they were in the States. If this be so, to a certain extent it is only to be expected, as we have had so much larger experience with shaft mines; but to return the compliment, I expect that as soon as more shaft mines come into operation in the States, American engineers will get more skilled in the application of machinery to them, and may possibly even excel us as they have done in so many other mechanical things.

A shaft 12 or 15 feet in diameter for a depth of 2,000 or 3,000 feet,

is a great expense, costing anything from $50 per yard of depth, or $1.75 per cubic yard excavated, to $600 per yard of depth. The shafts are usually circular and lined with bricks, but where the water pressure is great, with cast-iron segments.

In America one frequently meets with cases in which no pumping is required, the water running out of the mine by gravity, the haulage being practically horizontal is also a much less expensive item. The mines are almost entirely free from gas, which is no doubt greatly due to their being so much nearer the surface, thus permitting the escape of gas through fissures.

English mines are worked almost entirely on the "longwall" principle, and the use of this system is on the increase. The chief remaining system is that known as the "bord and pillar," which is more used in the north of England and in Scotland, while in America, of course, the system is almost entirely "pillar and room." In the best modern practice not more than 35 per cent. of the coal is removed when "working in the whole" (i. e., the preliminary work of driving the bords and walls). The removal of the pillars, which takes place as soon after the "whole" work as possible, is called "working in the broken" and the price paid per ton for the latter work is less than for the other.

To give actual figures referring to the use of coal-cutting machines in the two countries:—311 such machines were in use in Great Britain in 1900, whereas in America there were 3,907, or about 12½ times the number, this figure corresponding approximately with the ratio of the percentages cut by machines in the two countries, namely, 1½ per cent. and 20 per cent. It should be pointed out, however, that as British mining is very largely on the longwall system, the 311 machines include a large number of longwall and heading machines, while the 3,907 machines in America include 2,350 of the pneumatic percussive type, which is of course a much smaller and cheaper machine. Still, in the States there were 1,509 chain breast machines and 48 longwall machines, and the increase in the percentage of coal mining by machinery in West Virginia was from 9.27 per cent. in 1889 to 15.09 per cent. in 1900. The corresponding increase for Pennsylvania (considering the bituminous coal only) was 29.67 per cent. to 33,65 per cent.

In the matter of electric haulage, I have not yet had an opportunity of visiting a British mine in which the trolley system is installed, though I understand that one or two are in use. I have, however, seen electric energy transmitted from the pit mouth to the bottom and there used for driving an endless rope for haulage purposes. Steel

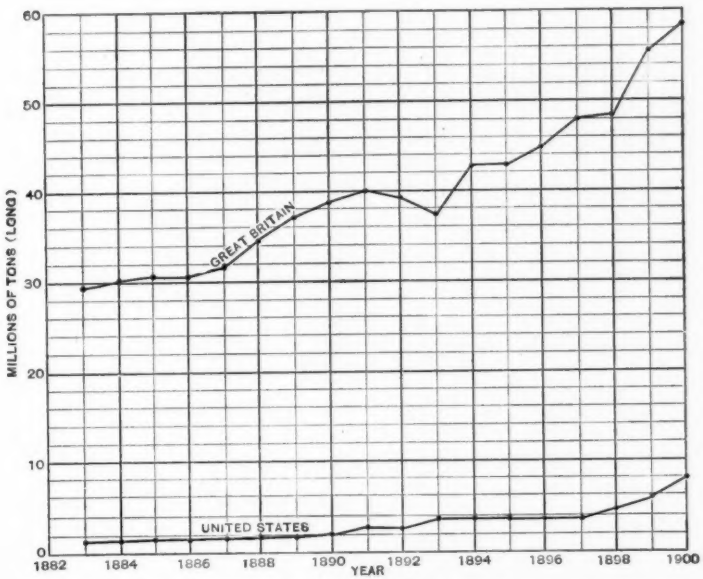
rope haulage (under and over) is largely used, the same three systems as occur in America being found, namely:—(1), direct rope haulage; (2), the main and tail rope system; and (3), the endless rope.

Electric energy is also used for pumping, lighting, and coal cutting, but all of this on a very small scale, and one likely to increase at the usual slow rate that such new ideas are taken up in Britain, where labour unions give considerably more trouble than they do in the States. The lack of the use of the machinery in Britain, however, most certainly is not due entirely to the unreasoning or incorrect conclusions of the labour unions, for there are many instances in other trades in which more and better machinery could be employed without displacing any men, though increasing the quality and output.

Another point which is in favour of America as regards cost of production is that in England in most cases subsidence has to be prevented as far as possible, on acount of damage to property on the surface. In America the land above the coal beds usually belongs to the firm doing the mining and does not have much valuable house property on it, but in England the land usually belongs to a large landowner who rents the mineral rights to various mining concerns.

The forms of energy used for haulage have already been mentioned. The gauge of the track is usually 24 inches, through it varies from 18 to 30 inches. The rails are of steel and rather lighter than those used in the States. They are spiked to the sleeper or ties much in the same way as is the American practice with the large railroads, thus differing from the English railroad companies' practice of using iron chairs. The mine cars are called tubs in England, and as in America are usually of wood, but their capacity is smaller, namely from 1,300 pounds to 1,600, though larger ones are used in South Wales.

Pumping is a very large subject, and the whole of this issue could easily be taken up with a description of it. There are plunger and bucket pumps and various combinations of the two, but the most interesting feature of British practice to an American colliery engineer would be the fact that many of these are worked by long wooden pump rods called "spear rods," some 10 inches square, extending right down the shaft from the surface and driven by beam engines, or by horizontal engines by means of a system of huge balanced timber bell-cranks. The old Cornish pumping engines are quite classic and their efficiency is higher than might be supposed. In the case of plunger pumps, the function of the engine is to raise these spear rods, and their weight is more than sufficient to force the ram back against the water pressure. Another system employs steam pumps fixed down the mine and oper-



CURVES SHOWING THE EXPORTS OF THE TWO GREAT COAL PRODUCING COUNTRIES.

ated by steam conveyed to them from boilers at the surface. Yet another is to generate hydraulic power at the surface and convey this down the shaft to pumps at the bottom. In this case the exhaust water from the power end of the pump is pumped up with the water from the mine, though in one arrangement there is a double set of high pressure pipes, one connected with each end of the pump power-cylinder, the water in these acting as a water rod for forcing the piston back and forth. Lastly, there are electricity and compressed air.

The coal is brought to the surface in the tubs or cars sometimes one at a time, sometimes eight at a time; in the latter case two are usually placed on each deck and there are four decks to the cage, which is a steel structure guided by fixed vertical ropes. On coming to the top of the shaft the two tubs on the bottom deck are pushed off, then the cage is lowered to the level of the next deck and so on. The methods of dealing with the coal after it reaches the surface are very varied, but on the whole they are similar to those in use in America. As the coal leaves the mine, however, a great difference is noticed. The British coal trucks hold only 6 or 10 tons each. These are almost the only two sizes made, though quite recently the Lancashire & York-

shire railway have built some 30-ton wooden trucks, (the 6-ton and 10-ton size being also made of wood) and the London and North Western have some 20-ton trucks. In America, of course, the 50-ton pressed steel car is a familiar and fine sight.

The next considerable difference between the two countries is the freight charges per ton mile, this figure in England being about six times what it is in America. The difference in the sizes of the cars accounts partly for this, but the relative cost of the land is perhaps a larger factor. The cost of British railways, including rolling stock, is stated to be $235,000 per mile, while the corresponding figure for America is I believe $60,000, or only a little over one-fourth of the amount. This is an enormous handicap and one which I fear is not likely to be removed or reduced. On the other hand, the value of land is likely to increase in the States, but probably Americans will not pamper the landowner to the same extent as is done in Great Britain

On arriving at the docks the coal is handled by mechanical tipples much in the same way in both countries, but again to a less extent in pamper the landowner to the same extent as is done in Great Britain. is at present manyfold the greater, the figures being as follows:

	Imports. Tons.	Exports. Tons.	Excess of Exports. Tons.	Percentage that the excess is of the total product.
		1899.		
Great Britain.....	2,000	55,810,000	55,808,000	25.3
United States.....	1,329,950	5,752,150	4,422,200	1.95
		1900.		
Great Britain.....	10,000	58,405,000	58,395,000	25.9
United States.....	1,881,637	7,917,319	6,035,682	2.5

The *Daily Mail* of 6th Nov., 1901, stated that there was a "steady and considerable increase of American coal exports to France" and that "the exports of English coal to Marseilles for the first six months of this year show a decrease of 25 per cent. from those of the same time last year. American exports there for the same time show an increase of over 1,100 per cent! This latter figure is probably misleading, without knowledge of the total amount of American coal sent to Marseilles; and the decrease in the British coal sent to Marseilles is no doubt partly due to the coal tax. Still, the figures show the trend of affairs. As the pitmouth value of American coal is almost exactly half that of British, and as there is not a very great difference in the quality of the coal of the two countries taken as a whole, it would seem as if the whole question of the possibility of American coal competing with British in the European markets depended on the cost of freight and handling between the respective mines and the markets.

THE VEVEY-MONT PÉLERIN FUNICULAR ELECTRICAL RAILWAY.

By Enrico Bignami.

The installation described by Signor Bignami in the pages immediately following is not of great magnitude, but it exhibits an interesting and rather unusual combination of power applications. A problem presenting exceptional conditions is solved simply by combining the separate peculiar advantages of several distinct agencies—the gas generator and engine, electric transmission and driving, the storage battery, and cable traction. For this reason the short descriptive account is presented.—THE EDITORS.

AMONG the numerous funicular or cable-operated railways with which Switzerland is provided, especially at much visited sites, perhaps the most perfect example is that from Vevey to Mont Pélerin. This line connects the city of Vevey with two villages, Chardonne and Beaumaroche, situated on the flank of Mont Pélerin, and having fine views as well as being pretty resorts for travellers in the neighborhood. It also greatly facilitates the ascent to the summit of the mountain which dominates one of the most beautiful panoramas in the world. The length of the line is 1,588 metres (0.984 mile), while the difference in altitude of the two termini is 416 metres (1,364 feet). The grades vary between 13 and 54 per cent., while the average gradient is 33.5 per cent. All curves are of 500-metres radius. There is one tunnel on the line 114 metres (377 feet) long. Retaining walls are built 5 feet thick at the top and 9 feet at the bottom. The line is ballasted for 960 metres and laid on mortar-jointed masonry for 660 metres. A gauge of one metre (3.28 feet) is used, the line consisting simply of two rails without a rack. The rail is 5 inches high and weighs 23.2 kilogrammes per metre (46 pounds per yard). Cross ties are of Zorès iron, 1.6 metres long at the bottom and 1.5 metres (4.92 feet) long on top. In all, the metal of the track weighs about 79 kilogrammes per metre, or 158 pounds per yard. The cable is 31.6 millimetres (1.26 inches) in diameter and weighs 3.25 kilogrammes per metre (2.18 pounds per foot). It is of twisted steel wire having a breaking strain of 134 kilogrammes per square millimetre, or, for the full cross-section of the rope itself, of 56 metric tons. Its maximum service load is 4 metric tons.

The mechanical equipment of the permanent way consists of pulleys for guiding the cable and keeping it from dragging on the ground. The rolling stock consists of two cars, one attached permanently to each end of the cable, so that as one goes up the other comes down. The cable is driven by means of a system of grooved pulleys worked by a 70-horse-power direct-current electric motor acting through a belt and gearing. Below is a detailed description of the machinery.

The motor is belted directly to a first countershaft. This, through simple gearing, works a second and more slowly turning countershaft which, in turn, drives in the same way a large countergear which is integral with the driving pulley. A guiding pulley is mounted near the grooved driving wheel. On the first countershaft are two powerful band brakes, one of which may be operated by hand while the other is automatic. The driving pulley is reversed by reversing the motor.

The electrical part of the installation was placed in the hands of the Société Anonyme ci-devant J. J. Rieter & Cie, of Winterthur, and comprises, in addition to the motor mentioned above, a battery of accumulators, placed at the upper station, a generating plant, and the transmission line. The generating station is situated about 40 metres from the stopping place at Chardonne. It consists of a trapezoidal building made of stone, having about 106 square metres of floor space and containing two generating units of 30 horse power each, of which one is held as a reserve. Each generating unit consists of a dynamo and a gas engine running at 150 revolutions per minute. The switchboard has white-marble panels supported on an angle-iron frame and is in three sections, one for each generator and an outgoing panel for the overhead transmission line and for the station lighting. On each dynamo panel is one amperemeter, one voltmeter, one field rheostat, one voltmeter switch, one 100-ampere switch, one minimum-current circuit-breaker and one pair of single-pole circuit-breakers. The middle, or line, panel has a rheostat, used in starting the gas engines by driving the dynamos as motors, an amperemeter, and two bipolar switches, one for the engine-starting resistance and one for controlling the lighting circuits in the station and its vicinity.

Current is taken to the upper station on two copper-wire cables, each 600 metres (1,968 feet) long and of 75 square millimetres cross section (about No. 00 B. & S. gauge). About 8 per cent. loss is encountered on this line at full load.

The line is attached to 50 double-bell porcelain insulators, supported by treated pine poles having pointed metallic caps. These are grounded by copper ground wires on each pole. To protect the in-

GENERAL VIEW OF THE RAILWAY LINE AND ITS SURROUNDINGS.

stallation as far as possible against lightning, a double-pole lightning arrester is placed at each end of the line.

The upper station contains a battery of 114 cells of Pollak accumulator, these having been made at the Marly works, near Fribourg. Their dimensions and constants are: Capacity, 402 ampere-hours at three-hours discharge, or 276 ampere-hours for one-hour discharge. Normal maximum charging current is 180 amperes. Sometimes, though, when the descending car is full and the car coming up is empty, as happens often in the evening, the motor works as a dynamo and its current of about 200 amperes charges the accumulators. Current on discharge varies up to 250 amperes according to the weight of the loads of passengers. The battery is intended to aid the generating station at the moments of heavy load, when it discharges in parallel with the generators. At times of small load it receives its charge, as it does also during the intervals of rest between trips of the two cars. By this arrangement the generators are driven constantly at full load, and consequently at maximum efficiency. Otherwise their power would be notably insufficient, as the generator output is calculated upon the basis of the average power consumption, instead of being provided to meet the maximum-load conditions. Except for a few trips in the morning and late in the evening, the battery is used alone. It serves also for lighting the plant stations and offices and, most important, the buffet at Beaumaroche.

A singular phenomenon takes places during the first part of the

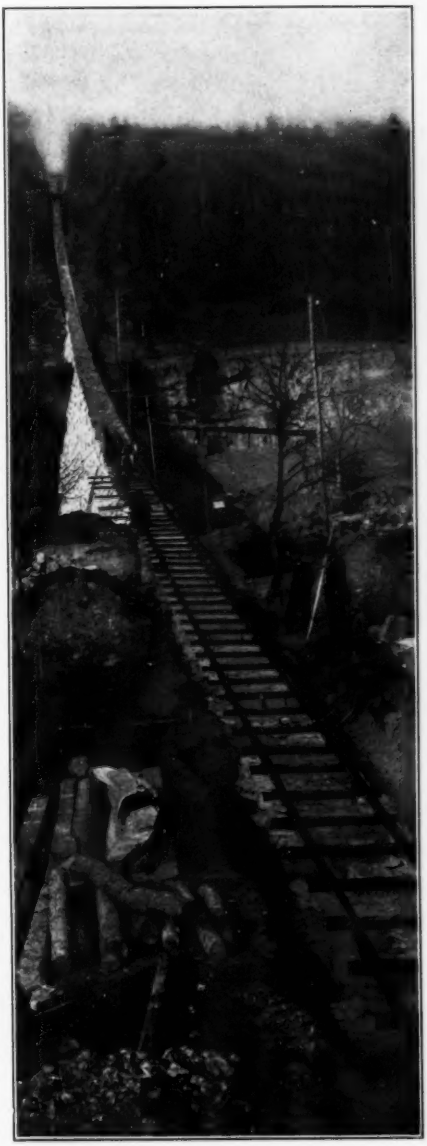
trip, when the ascending car is on a 13-per cent. grade and the car coming down is on a 54-per cent. grade. The motor is perfectly reversible and, driven by the descending car, is worked as a dynamo, restoring current to the battery.

In order to eliminate variations of voltage due to variations in load, the battery is provided with an automatic apparatus of the C. Schneider system which controls a group of end cells. The automatic apparatus is worked through a voltmeter contact-maker and a relay.

THE SUBSTRUCTURE OF THE VEVEY–MONT PÉLERIN RAILWAY.

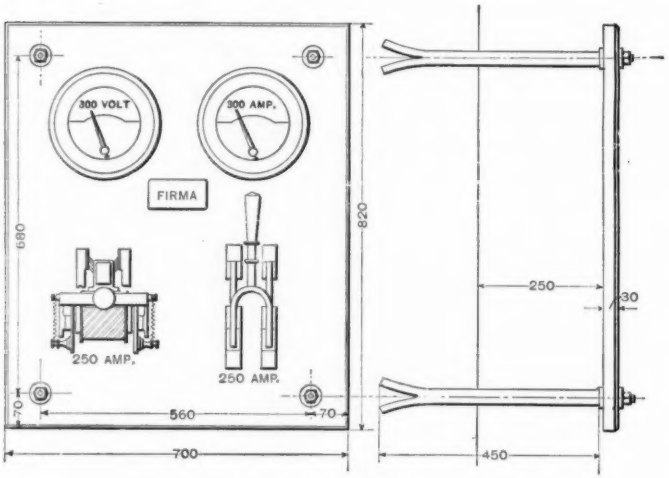
The accumulators are installed in the basement, upon a wooden rack completely insulated from earth. The switchboard and all the other apparatus find place on the main floor of the building. The controller and the motor switchboard (page 364) are directly at the hand of the operator, who also controls the brakes. The motor switchboard is of marble and contains an amperemeter, voltmeter, bipolar switch, minimum-current circuit-breaker, and a pair of cut-outs. The battery switchboard, which is near the motor, contains two amperemeters, a 300-volt voltmeter, an 80-ampere throw-over switch, a single-pole 250-ampere switch, and a bipolar switch for the lighting circuits. The method of distribution is shown on page 370.

Each of the two cars composing the rolling stock has thirty seats and can carry also twelve standing passengers. Empty, these cars weigh 5,200 kilogrammes (11,440 pounds) each, and loaded, 8,140 kilogrammes (17,900 pounds). Their wheel-base is 4.3 metres (14.1 feet) and the permissible speed 1.5 metres (4.92 feet) a second.



Each car has both hand and automatic brakes, and in case of breakage of the cable both act instantly to secure the car to the track by means of solid steel wedges. The operation of the trains is controlled by the operator at the upper station who has command of all the machinery.

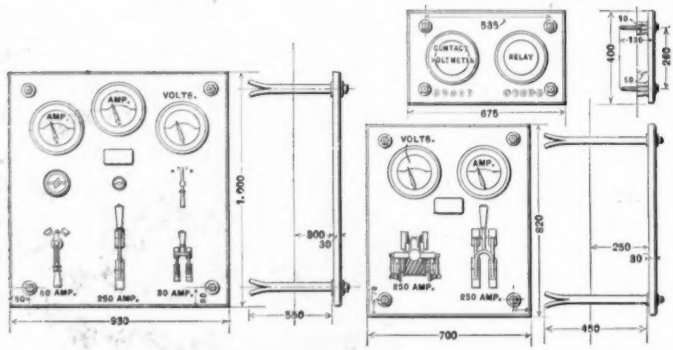
A word may be said here about the gas-generating engines, which were installed by MM. Gilliéron & Amrein, of Vevey. Each unit comprises the engine proper and a gas-making apparatus. The working of the apparatus is as follows: Gas is produced in a contrivance resembling an ordinary stove, in which steam and air are caused to pass through incandescent anthracite coal. The resulting combination is termed *gaz pauvre*—"poor



THE CONTROLLER AND THE MOTOR SWITCHBOARD.

gas." From the generator the gas goes to a second apparatus, called the washer, where it is cleaned and purified. From the washer it is drawn directly into the engine cylinders as demanded. The method of working one of these engines is thus:

A wood or charcoal fire is made up in the generator cylinder, A, preferably newly cleaned, and the two doors, B and B_1, are carefully closed. The three-way cock C is set so as to keep the smoke out of the washer D and to allow it to escape freely by the chimney E. The washer D is



THE BATTERY SWITCHBOARD.

now filled with water through the valve V until it overflows by the tube T after having filled the pot U. The vapouriser should also be filled half-full of water. If it is desired to force the fire and hasten the production of gas, use is made of the blower N by turning the crank energetically in the direction shown by the arrow. The current of air from the blower enters the lower part of the generator and, after passing through the grate, traverses the cylinder A. During blowing the cock Q of the water-level gauge should be open and the valve S of the steam pipe W closed.

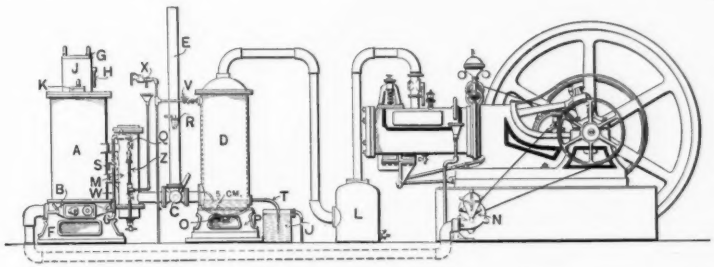


DIAGRAM OF GAS GENERATOR AND GAS ENGINE.

The fire being well started, the cover G is lifted and the charging hopper J is filled with combustible (anthracite or very lean coal in lumps of one inch or smaller). Replacing the cover G a gate is opened by lifting the lever H, permitting the coal to fall little by little into the cylinder A. Care must be taken always that too much coal does not enter the cylinder at once, as this would result in extinguishing the wood fire. It should be admitted in small quantities at frequent intervals. The generator A being filled in this fashion up to the conical funnel and all the fuel being well-ignited, a second charge is put into the cylinder A, the air outlet cock Q is closed, and the steam valve S is opened, the hopper J being at the same time filled with anthracite to be warmed for the next charge, thus avoiding cooling the fire.

In ten or fifteen minutes after firing the gas can be tested to see if it is of usable quality, which is known by the gas issuing from the test cock R burning fully under pressure with a blue flame. As soon as good gas begins to be generated, the three-way valve C is turned to shut off the opening to the chimney E and to allow the gas to pass to the washer D and the pot L. At the same time the crank of the blower N is uncoupled and a belt connecting it with the engine thrown on. The

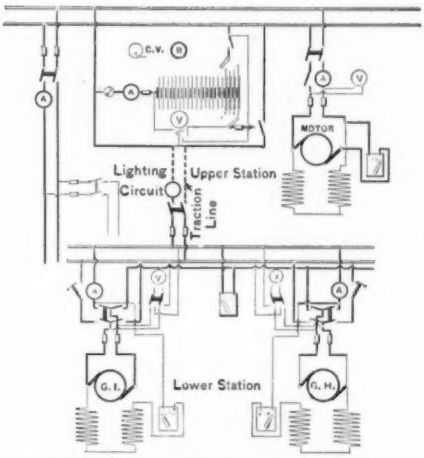


DIAGRAM OF THE METHOD OF DISTRIBUTION.

engine can then be started. The height of the incandescent column of coal will be maintained always at the point determined by the needs of the case and in the manner indicated. The progress of the operation is indicated by the peep-hole or window K. As soon as fire becomes visible through it a new charge of anthracite is fed into the cylinder.

The two doors, B and B_1, are provided with openings through which the fire may be raked and sliced with tools furnished with the machine. If the glow of the fire on looking in at these doors is not of a bright red, the grate must be cleaned with the pokers mentioned above.

The height of water in the boiler M should be kept the same by watching the indicator Z and using the feed-valve X. The washer requires a constant small supply of cold water which enters by the siphon T, and care must be taken to keep the latter free from obstructions. In going into the washer the gas should traverse a layer of 2 inches of water, which prevents its return to the generator.

After half-a-day's running the plug at the bottom of the washer is removed to flush out the dust and impurities which have accumulated in it. Every day, before putting the apparatus to work, the bottom of the evaporator is unscrewed and emptied. The tubes of this apparatus are also cleaned every few days by means of a brush of iron wire. At the end of a day's run the doors B and B_1 are opened, the grate is tipped, and the cylinder A is cleared of clinkers and ashes.

During short stoppages of running the fire is allowed to burn after all the openings and all the valves have been closed, except a small hole in one of the doors B of the base of the generators, and the three-way valve is turned so as to open a path to the chimney by the smoke flue E.

If it happens that the engine receives no gas, the cause may be an obstruction of the pipe between the evaporator M and the generator by fragments of coal, or the buckling or obstruction of the siphon T. In

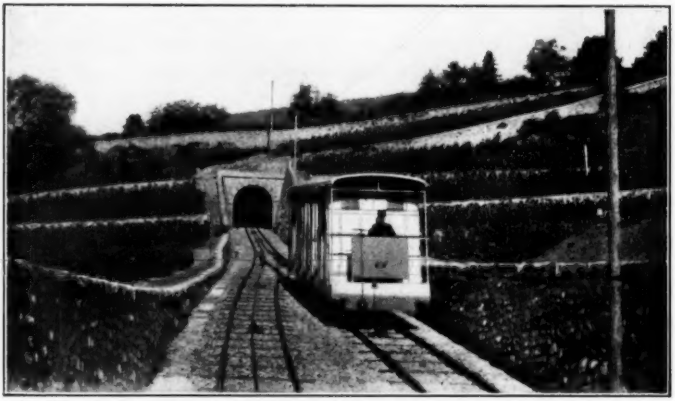
the latter case the water cannot escape and fills the washer D, the three-way valve C and the evaporator. It becomes necessary, then, to draw off the water by opening the plug O and to clean the siphon.

The consumption of the engines per horse-power hour is 0.60 to 0.65 kilogrammes (1.32 to 1.40 pounds) including the two startings necessary in a day. The same consumption calculated on an annual basis shows 7 kilogrammes used per double train trip, or about 2 kilogrammes per car-kilometre (7.1 pounds per car mile) in which is included lighting the line and the *buffets* of the terminal stations.

Preliminary diagrams showed that in working the line at the time when conditions would be the worst—that is, when the up train was loaded to its maximum and the down train was empty, about 60 horse power would be required. In practise the maximum often surpasses 100 horse power. In spite of this the engines and the electrical apparatus have given excellent service, even at the times of heaviest loads. On Sundays in the summer the service has been suspended during the greater part of the day.

The Vevey-Chardonne-Pélerin cable railway, installed under good technical conditions, gives also very good financial results. Since its opening it has carrried an average of 13,000 passengers a month

A PORTION OF THE COMPLETED PERMANENT WAY.



TUNNEL, PASSING POINTS, AND CARRIAGE DESCENDING.

and about 120 tons of merchandise under a schedule of 20 trains a day.

The time table shows a train every hour from 6.15 a. m. to 11.15 a. m., from 11.15 until 12.15 a train each half-hour, the same from 1.15 to 4.15, and from that time until 10.15 the trains are again run at hourly intervals. The trip is made in 24 minutes with a single intermediate stop at Chardonne.

The rates of fare are as follows:

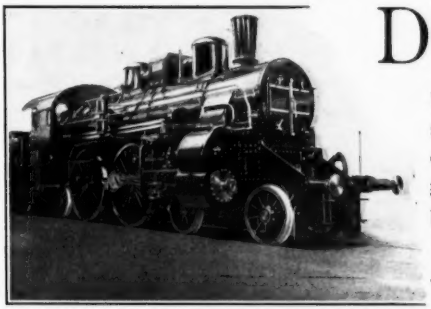
Ordinary ticket	.....	2d class round trip, francs 2.10
" "	.....	3d class, round trip, francs 1.50
" "	.....	2d class, up trip, francs 1.40
" "	.....	2d class, down trip, francs 1.00
" "	.....	3d class, up trip, francs 1.00
" "	.....	3d class, down trip, francs 0.75

The good technical and financial results shown by this enterprise will doubtless contribute to the development of working inclined cable railways by electricity.

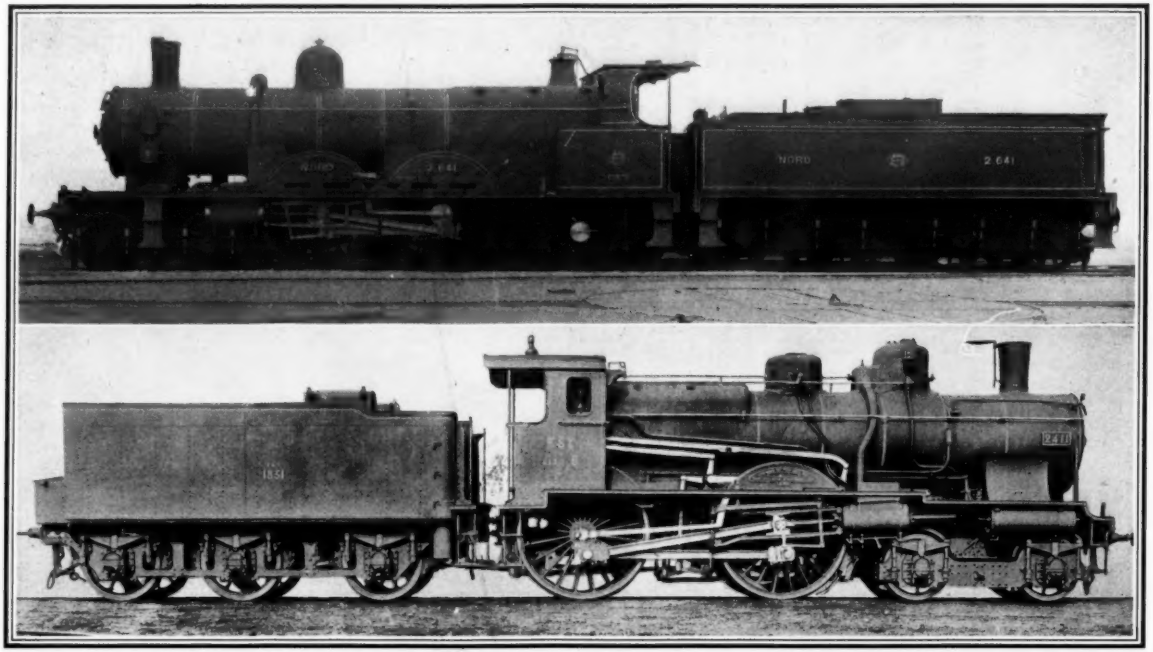
FEATURES OF CONTINENTAL LOCOMOTIVE CONSTRUCTION.

By Charles R. King.

The fact that the railway is essentially an agency of internal transportation, while the waterway is worldwide, has tended to keep locomotive engineering to a great extent within national boundaries in its development. This is particularly true of countries like Britain and the United States, which are isolated by their position. Britain, as the great engineering exporter of the world, reached farther abroad, but it was largely to extend her own practice into new lands. It is but recently, since the demands of the lately opened continents overtaxed the old sources of supply, that comparison between diverse types developed under differing conditions has become keenly interesting. Continental locomotive practice has afforded the freest opportunity for the interchange of ideas and systems developed separately under varied conditions of temperament and influence. It should afford the best examples of mechanical construction resulting from the co-operation of minds of many complexions. Mr. King's long and varied experience enables him to apprehend the characteristic points of the types he reviews, and his grouping of the subjects permits him to cover the field comprehensively in this article and the succeeding papers.—THE EDITORS.



DURING and since the period of the recent Paris Exhibition much has been published upon the section there which was devoted to locomotive engineering. For the greater part these descriptive reviews, although at all times interesting, have either been very generalised or else confined to detailed descriptions of individual machines chines—excellent in themselves, but appearing in so desultory a manner as to require for many a considerable effort of memory to retain all that had appeared thus intermittently on the subject. A review of the whole which selected for remark the principal novelties of construction or other equally interesting elements of design, exhibited in each locomotive, accompanied by a short general and comparative description, would, it seemed to me after seeing in actual service many of those exhibited, form a useful record of a very remarkable exhibition—the greatest of its kind and representing, locomotives and cars together, an immense outlay of capital for the period of almost one year. Hardly sufficient justice appears even yet to have been done, many an ingenious



ABOVE IS THE WELL-KNOWN FOUR-CYLINDER NORD COMPOUND EXPRESS LOCOMOTIVE; BELOW IS THE FOUR-CYLINDER COMPOUND OF THE EASTERN RAILWAY OF FRANCE—THE ONLY FRENCH FOUR-CYLINDER ENGINE DIFFERING FROM THE NORD TYPE IN ITS STARTING GEAR. IT HAS THE "EST" STARTING VALVE.

mechanical contrivance having so far passed without notice. At first sight it might appear that the matter was now out of date; but machine design does not change or progress thus speedily, and the locomotives exhibited at Paris were, for the greater part, entirely new types. Some of them have not even up till now completed that experimental stage which precedes the establishment of a regular class of new locomotive, and such a type when thus fixed in Europe usually remains the standard for at least four or five years following.

If anyone were to look for anything remarkable in European locomotives with regard only to mere size and power, as in America, he would certainly be disappointed. Continental exactions in the direction of luxury in travel follow but slowly—though none the less surely—in the wake of American progress. Moreover, the limit of the loading gauge presents, or will present very soon, an impediment to most European railways (always excepting those of Russia); in England, indeed, were it not for the great calorific value of the native coal, railway engineers would have long since been baffled to have kept their locomotives small enough to pass through tunnels of such rabbit-burrow like proportions (as compared with those existing abroad). And yet, very singularly, it was here that the great Brunel gave the country a width of railway unique in the world. But apart from mere size and from the point of view of shapeliness alone, something desirable might be learnt of the æsthetic in the forms employed for the parts in European locomotives.

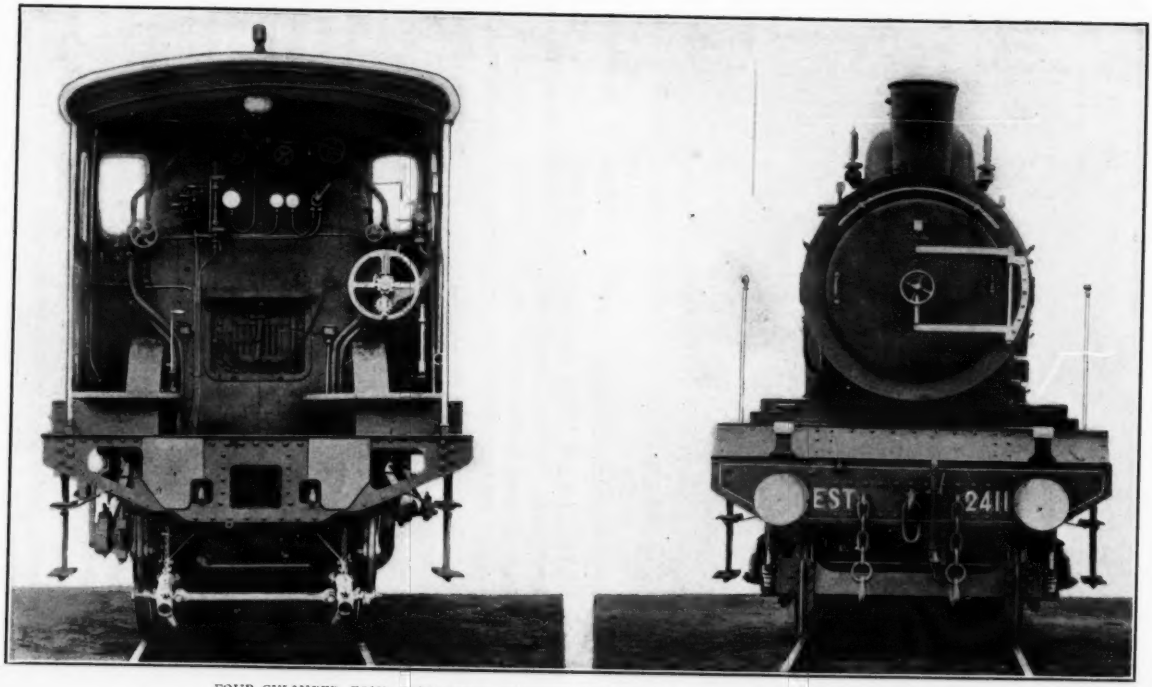
Continental engineers have a sharp eye for harmony in design, and many a question is asked as to why American locomotive parts could not be lightened to give a little more semblance to elegance (*moins grossières*) without any loss of strength. It is also very interesting to observe in Continental locomotives the greater variety in the general external appearance, even in locomotives of the same type, and this is not without a picturesque effect, reflective surely enough of the innate sentiment of art possessed in many European countries by such unimpressionable men as locomotive designers. An example of pleasing harmony in mechanical design was particularly noticeable in two locomotives at the recent Paris exhibition, viz., the English Midland Railway single driving wheels express locomotive and the ten-wheeled four-connected express locomotive designed at the Chemnitz works for the Saxony State Railroads; but for crushing mass and even higher finish of parts there were many other examples to be seen.

Express Locomotive, Northern Railway of France. The first place in this notice properly belongs to French locomotives, and, of these en-

gines, that one which was exhibited by the Northern Railway—a line which holds with the Paris-Orléans the premier position for the fastest regular services of passenger trains on the Continent. The latest type of Nord locomotive here illustrated shows nothing remarkably new in its construction, being the result of gradual changes effected in its prototypes; and a short description of its evolution will embody the history of the development of the four-cylinder express compounds in France and indeed in the world.

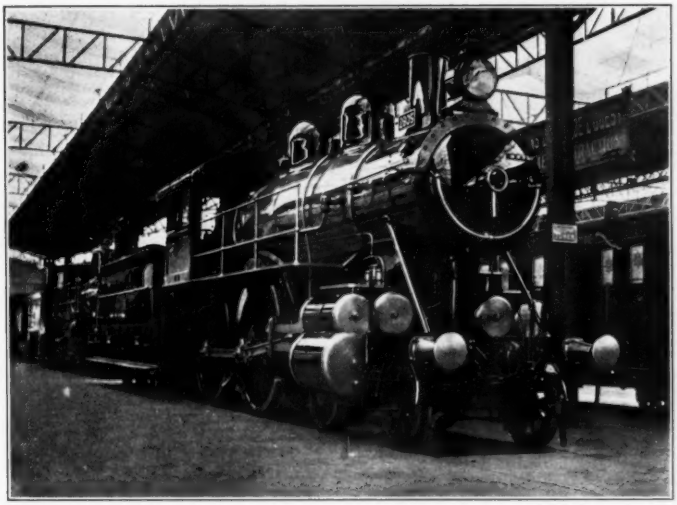
At a time (1886) when Mr. Webbs' English North-Western three-cylinder compounds had become a practical success, and a specimen had been sent to the Western Railway of France, as was done later (1888) to the Pennsylvania Railroad, the noted firm of French locomotive builders, the Société Alsacienne de Constructions Mécaniques of Belfort—the regular maker of the Nord locomotives—constructed a four-cylinder compound for the Nord Railway, taking as the model a precedent type of Nord six-wheeled four-connected engine having a large pair of leading radial wheels beneath the smoke box, but differing from all expresses of that time in having single instead of double plate frames. The high-pressure cylinders were placed inside the frames, working the forward pair of drivers, and the low-pressure bolted outside the frames, driving upon the trailing wheels, but without any side rods connecting the two pairs. This engine, designed by Mr. Alfred G. de Glehn of the Alsatian Company, at once effected an economy of 18 to 19 per cent. on coal. When it had been several years in service it was exhibited at the Paris Universal Exhibition of 1889. After running 390,555 miles it realised over single-expansion locomotives doing the same work an economy of 2,260,720 pounds of coal, which reckoned at $3 per metric ton represented $3,083 or. in deducting $160 for its extra cost in lubricating oil, a net saving of $2,923.

Between the years 1876 and 1891 the fastest Nord trains were, with the exception of two locomotives, worked by a very fine eight-wheeled four-connected type of engine known as the *Outrance*—created in 1876 by M. Delebecque and first exhibited at the Paris Universal Exhibition of 1878, and of these a total of 103 have now been built. With this engine 150 tons or 26 axles was considered to be a heavy load, and on the ruling gradients of 0.5 per cent. the maximum speed with such a train load did not exceed 40 miles per hour. Even when, later on, the boiler-pressure was raised from 134 pounds to 148 pounds and the cylinder rebored to a larger diameter, the engines could not, with the allowance of any margin for adverse weather, keep time on the same gradients with trains of more than 32 axles



FOUR-CYLINDER FOUR-CONNECTED EXPRESS ENGINE, EASTERN RAILWAY OF FRANCE.

or 200 tons. The experimental compound, No. 701, carried a pressure of 148 pounds and trials showed that it exerted a power of 750 metric horse power. Along with it, at the Paris Exhibition of 1889, there was shown also a new type of single-expansion engine designed by Chief Engineers F. Matthias and M. Sauvage with 19-inch cylinders, No. 2101; but being larger and more powerful than the compound and carrying 161 pounds pressure, this engine was able to mount the 0.5 per cent. grades with 190 metric tons at a speed of 45 miles per hour. It was soon found, however, that the work to which its crank axle was subjected was too great, and this fact added to the low cost of upkeep of No. 701, decided the final adoption of the four-cylinder-compound arrangement, which divided by half the work on the crank-pins and reduced the stresses on the cranked axle, while the superior twisting moments of the four driving rods, even without side connecting rods, greatly increased the regularity of the pull on the draw-bar, as I had several opportunities to notice during the early service of the compound No. 701. The Exhibition engine, No. 2101, with the addition of compound cylinders, therefore became the pattern on which succeeding and more powerful engines were built. The first of this primary class began work on August, 1891, and since that time, with various and successive alterations of dimensions, sixty of the series have been built. In these compounds, designed by M. du Bousquet (the then new chief of the traction department) the position of the cylinders was reversed from that in No. 701, the low-pressure cylinders being placed inside the frames where the momentum of their heavier reciprocating parts had the least disturbing effect, and the high-pressure cylinders being located outside—just as in Mr. Webb's three-cylinder arrangement, and although the first two of the new series had no connecting side rods, these were applied very shortly afterward in order to compensate the tangential efforts on the cranks, to insure promptitude of starting in all positions of the pistons, to diminish the maximum vertical oscillations, and to maintain the two sets of crank pins always at the same relative angle. In the new compounds it was moreover arranged to exhaust the high-pressure cylinders direct to the atmosphere whenever necessity occurred, and at the same time to send live steam direct to the low-pressure cylinders. The boiler pressure was augmented—188 pounds—and compared with No. 701 the new engine indicated a power, during trials, of somewhat over 1,000 horse power, although having a grate area less than that of the old *Outrance* type. The 0.5 per cent. grades were now ascended with 200 tons at 47 miles per hour. One of these first two engines was sent to Chicago in 1893,



VAUCLAIN COMPOUND, STATE RAILWAY OF FRANCE.

and the same type of compound was then adopted by the Southern Railway of France. Later—in 1896—the succeeding classes had boiler pressures raised to 201 pounds, the boilers were enlarged and fitted with Serve's ribbed tubes, the grate area was increased, and the engine supplied with modern double-truck tenders; the speed up grade with 200 tons was then augmented to 51 miles per hour. In March, 1897, one of the new engines hauled a train of 225 metrical tons up a grade of 0.5 per cent. at a speed of 53.7 miles per hour, and without forcing the boiler to its utmost the work developed on the pistons was 1,155 metrical horse power. In these trials certain abnormal fluctuations were noticed in the high-pressure valve-chest, as well as an undue compression on the low-pressure pistons; these defects were remedied by increasing the size of the dry pipes and the capacity of the high-pressure valve-chests and by giving an extra inside lead of 1/16 inch to the 1/8 inch already existing with the low-pressure valves. The maximum speed on the 0.5 per cent. rising gradients with 200 metrical tons now advanced to 53.6 miles per hour. Finally the lengthening of the firebox shell to 9 feet 10 inches compelled the adoption of a trailing wheel beneath the firebox (Atlantic type), as has been practiced for over twelve years by the State Railways of Belgium and the French Paris-Orléans line.

The following particulars of this engine are given at some length for the reason that most French lines have abandoned their former variable distinctive types by preference for this one. Thus the Midi, Paris-Orléans, and Ouest use the same form of compound locomotive with slight modifications of detail.* The fuel used is a mixture of coals obtained from the mines of the Nord and Pas-de-Calais departments, containing 20 to 23 per cent. of volatile matters and 5 to 6 per cent. of cinders, and is in the form of small pieces and slack mixed with briquettes. By dint of rapid firing about every five minutes and closing the door the instant the shovel is out of the firehole, this coal can be made to keep the steam pressure constant with an almost invariable water level while hauling loads of from 270 to 350 tons at speeds varying from 53 to 75 miles per hour. The consumption per American ton-mile, excluding the locomotive and tender, ascertained during certain trials is 0.111 pounds, or, including the locomotive, only 0.08 pounds. The average of the gross loads, from which these figures were supplied, was not given; but even supposing this to be 400 metric tons it is not possible to make out the train mile at more than 35.2 pounds, which is certainly a very remarkably low fuel consumption. The grate, taken horizontally, has an area of 29.5 square feet, the heating surface in contact with the fire is 2,243.4 square feet (ratio grate area to heating surface, 1:76); the pressure is 215 pounds; the cylinders 13⅜ inches and 22 inches diameter by 25¼ inches piston stroke, and the drivers 80¼ inches diameter; theoretical maximum tractive effort, 25,806 pounds. The boiler is of perfect telescopic type, the 11/16-inch thick rings diminishing in diameter from the smokebox backwards, in order to keep the boiler center as low on the wheels as possible—8 feet 3 inches. The material for the rings and firebox shell is mild steel of 32.6 to 36.6 (U. S.) tons maximum tensile strength with 33 to 31 per cent. elongation. The firebox shell is of the square-cornered or Belpaire pattern, with a very deep copper firebox contracted in its width below in order to find room for the firebox casing between the inside plate frames—an arrangement which makes it necessary to leave the shell plates open until the inside box is inserted in its place. To keep up the water circulation, and prevent steam bells forming between the narrow water spaces at the sides, the foundation ring has been increased in the width of its edges as compared with the previous engines. Ordinary vertical crown stays of iron are used, except for the two front rows which are expansible. All of the screwed stays are of manganese bronze, drilled

* Those of the Paris-Orléans lines, while less powerful than the Nord locomotives, make, on an average, speeds of 56 to 59.7 miles per hour between Paris and Bordeaux.

right through, and their fire ends are opened out after rivetting. The flat sides of the firebox above the crown are stayed by a double row of transverse rods. Longitudinally the boiler head is stayed with four rods, screwed to girder stays on the back plate and to brackets on the rear boiler ring. There are 126 tubes (Serves) of 2¾ inches outside diameter. The tube plates (⅝-inch thick) and the boiler head, 1-inch thick, are of extra mild steel with an ultimate tensile strength of 29.3 to 32.6 tons (U. S. measure) with 36 to 33 per cent. elongation. All rivets, including those for the copper firebox, are of the best iron of 23.2 tons tensile strength and 23 per cent. elongation. The brick arch, which has long since replaced the water table or copper midfeather employed in the first compounds, is of circular form with vent holes against the sides and middle of the flue sheet. The grate is slightly inclined and divided into five short rows of multiple bars, the front one being a hinged dropping grate with transverse bars. Shaking grates are so far not used in France.

The petticoat pipe in the chimney is completely closed by a circular grating above the blast nozzle—a plan adopted from the first for these compounds—and although this pipe is large, yet its spark mesh is of very small area compared with the usual pattern of spark baffler; but as these engines have always steamed freely in spite of the confined area of the netting, it would appear that too much stress is sometimes laid upon the draft obstruction said to be created even by the regulation spark arresters. The blast pipe is surmounted by the standard double-wing variable nozzle permitting a perfect control of the fire, so important to firing with slack in mounting grades; otherwise, with fixed nozzles, a large proportion of the coal would be carried straight through the tubes, to the passengers' discomfort.

The spherical-topped dome incloses a semi-balanced throttle valve worked by the usual form of pivoted rod, and the dry pipe, as is the custom almost exclusive to France, is taken by a short way to the high-pressure cylinders in being passed through the boiler close to the dome and thence down, beneath casings, to the high-pressure cylinders; but whether the lessened frictional resistance effected by a shortened pipe is compensated by the increased chances of condensation outside appears doubtful. The high-pressure cylinders are bolted outside the frames in line with the steel-casting box frame, which serves as an inside transverse frame brace and also as a support for the low-pressure valve-spindle brackets at its front face and for the low-pressure cross-head bars at its back face. The small cylinders are bored clear through, but the large cylinders have semi-closed back ends. The serious loss by con-

densation resulting from the exposed position of the forward ends of the outside cylinders has obliged a thorough jacketing of their front heads with a non-conductor. The boxing in of the piston rods of such outside cylinders would appear to be a refinement that has so far remained unstudied, yet the loss of thermal efficiency due to each high-pressure piston rod spending half of its working time in the outside air, oftentimes of a temperature in winter below zero, might well be worth prevention by the use of a few square inches of sheet iron, of a flexible jacketing, or of closed cylindrical guides. In an engine normally working at high speeds the bridling effect of excessive compression has been counteracted to some extent in the clearance volumes, and for these, in per cent. of volume of each piston-stroke, 14 in the high-pressure and 9 in the low-pressure has been considered enough by the Nord engineers, although as much as 18 and 12 per cent. respectively are allowed in Est express engines. Both sets of valves have also been given, in place of usual inside lap, an inside lead of 1/16 inch for the high-pressure, and 3/16 inch for the low-pressure, thus reducing the period of compression.

The proportion of volume, high-pressure to low-pressure cylinders, is 1:2.71; in the earlier compounds that ratio was 1:2.42 only. The total cubic capacity of the receiver is 5 times the volume of that due to the stroke of one of the high-pressure cylinders.

The relief valve is mounted on the left side of the smokebox, and in connection with these reservoir passages is set at 80½ pounds. Its pipe is placed symmetrically to that of the live-steam pipe on the opposite side of the smoke box, the two entering the saddle casting on either side of the blast pipe. The pistons are steel castings, the high-pressure having straight and the low-pressure conical webs. Extensions are provided to the low-pressure piston rods with a view to preventing the too frequent recurrence of broken cast-iron segments and also to save some amount of grooving from their relatively heavy weight. The cross-heads are of iron cemented and case-hardened and their slide blocks are of cast iron lined up with white metal. The main driving rods and the side rods are of forged iron and their channelling to I-section is effected by drop-forging. The high-pressure main-rod big ends are of open-forked pattern with their brasses held up by single gibs and cotters, and the inside low-pressure main rods and the side rods have strap ends with longitudinal screw adjustments.

Walschaert valve gear is employed for both groups, the inside gear being driven from eccentrics and the outside gear, as usual, by cranks. In these new engines special care has been taken to avoid wear wher-

ever that was possible; thus, to diminish bending stresses and lessen the work on the various pins and studs of the links, the eccentrics have been so keyed that the lower half-sector of the link drives the valve when in forward gear—that being of course the motion most frequently used. A new arrangement has also been adopted to suppress the torsional strain due to the different vertical planes usually occupied by the valve spindle and the advance lever. The valve rod is mounted in an extension buckle the cheeks of which are saddled upon a bracket guide, at the same time embracing the upper end of the vertical advance lever, which is now not bent laterally as usual, so bringing the various joints of the gearing into the same vertical axis. All the slide valves are of ordinary unbalanced pattern. At the lower outside edge of each low-pressure valve chest is located the compounding valve designed by Mr. de Glehn. Cylinders, boiler saddle, valve chests, and starting-valve cylinders are cast together in one piece and the latter are bored to receive a hollow rotary starting valve of the same internal diameter and lying in the same longitudinal axis as the exhaust pipes from the high-pressure cylinders. This valve has ports so located in its circumference that when the larger opening arrives opposite to the passage leading into the low-pressure valve chest the smaller port, farther forward, is blind; a quarter turn brings the latter opposite the passage to the valve-chest exhaust after closing the low-pressure hole. Another portion of the circumference opens the drain holes both for purging the valve chest and the starting valve itself. Motion is imparted to the rotary valve by a spindle passing out through a gland at the forward end, opposite to the high-pressure exhaust pipes, and there operated by a small air-cylinder and piston located beneath the front platform perpendicular to the axis of the valve and controlled, of course, from the footplate, as too is the special cock for admitting boiler steam to the low-pressure valve chest. The following effects are thus obtained:—Compound; single expansion in each group of cylinders when required for starting or auxiliary aid; disconnection of the groups and working either pair alone, as in case of accident.

The reversing-screw gear consists of two differential screws on the same horizontal axis, the turned-down or loose tail end of the front screw passing concentrically through the back screw, either one being disconnected at any desired point of cut-off by means of latches, and thus operated singly or together with the same or different relative degrees of expansion; while a third latch locks all movements of the hand wheel. Although steam reversing gear had been installed on the first Nord compounds, now in France, and almost everywhere else on the

Continent, this form of power gear is not used. The axles are of Martin steel. The crank axle, of Worsdell type, with strongly-hooped circular webs, is of gun steel tempered in oil. The main object in bringing the two driving axles so close together was to shorten and reduce the weight of the coupling rods. The introduction of the fifth axle is however considered by some French engineers more objectionable than the use of long rods. The wheels are of forged iron. An angle of 180 degrees has now been resorted to for the keying of the two groups of engines coupled by the side rods, in this point differing from the previous locomotives wherein the angle employed was 162 degrees. As now arranged the rotary masses are balanced without consideration to those of the reciprocating parts. On other railroads 162 degrees is found quite satisfactory with regard to the multiple conditions to be realised; on the Nord, however, calculation and experience have proved that with coupling at 180 degrees the side lash due to the alternating movements of four almost self-balancing engines has been reduced to a minimum, and that it is quite possible to ignore the latter masses in calculations for the wheel weights, as could not be done with keying at any different angle. Additions to wheel weights for equibalancing the maximum velocities of the reciprocating parts, while diminishing side lash (so aggravated in engines with free swinging or flexible bases at either end, as in the ten-wheel type) introduces vertical oscillation or galloping, attended with pounding of the rails; the engine under mention has therefore only counterweights of low value for balancing the revolving parts on each axle, and as these are symmetrically disposed on either side the same matrix can be used for forging each pair of wheels—a practice not convenient with the unsymmetrical locations of the heavier wheel weights in engines keyed at 160 degrees. The final result is that with 180 degrees the difference between the mean twisting moment and the minimum moments is scarcely higher than when 162 degrees is employed, so that the starting power is practically much the same whatever be the stationary position of the driving cranks. The slab frames are of extra mild welding steel 1 3/16 inches thick and stiffened over the leading driving-axle box guides, or horn blocks, by steel plates of horse-shoe form. The horn blocks are steel castings; the binders or yokes are cast iron and the wedges are of bronze. All the springs of the two pairs of driving wheels and the large trailing wheels are connected together by longitudinal balance beams.

The engine truck is of the model most generally employed in France, with plate frames outside the wheels and journal boxes outside the frames. Its transverse steel casting frame supports the engine

solely by means of two spherical feet, bolted beneath the sides of the main frames and sliding in grooved channels in the bed casting. The work of the pivot pin in having no step bearing is therefore confined to pushing the truck and to resisting the lateral thrusts of the latter, which are flexibly transmitted through the intermediary of two traversing helical springs of very different strengths threaded concentric-wise, one within the other, upon two independent rods and set in place at an initial tension of about 3,700 pounds, the amount of direct lateral play being 1⅝ inches on each side. The pivot pin is slightly tapered towards its neck and merely to avoid strain, for any independent vertical obliquity of the truck frame sides—as in flexibly running swing trucks—is prevented by the rigid side supports mentioned.

The boiler mountings are: two 3⅛ inch safety valves, one ordinary and one Adams' pop, mounted on a bronze pedestal; two large Friedmann's variable-feed restarting injectors, one of 9½ millimetres for supply and one of 10½ millimetres as assistant or reserve; water-level glass with Serveau's automatic closer operating when glass breaks; Bourdon's steam gauges; oil force-pump, located on right-hand running board, etc. The lubricant used is a mixture of 80 per cent, naphtha oil called *mazout* and 20 per cent. colza, serving alike for journals, cylinders, and motion, although the engine men use colza pure for a very few parts of the mechanism. The consumption is 11.26 pounds per hundred miles run.

A blow-through steam-tube sweeper is provided in the smokebox, and a perforated pipe, fixed along under the transverse locking stanchion, enables the dust to be laid and diminishes the chances of ashes getting into the low-pressure valve chest if ever the engine is run against reversed steam. The equipment comprises also Gresham sand jets to the fronts of both sets of drivers—the sand boxes, always so unsightly, being concealed by the wheel covers; an electro-motor whistle for receiving signals when the contact brush—visible at the back of the trailing drivers—sweeps the brass-backed *crocodiles* that are placed at intervals along the middle of the track on the Nord main line, and finally the Westinghouse brake with the latest type of air pump, the brakes acting upon the fore-ends of all wheels save those of the trucks. The peak on the chimney-front edge breaks the force of the wind and facilitates the egress of smoke when steam is cut off.

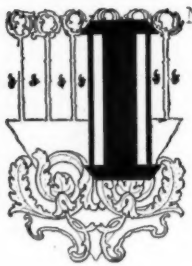
THE FACTORY OFFICE AS A PRODUCTIVE DEPARTMENT.

II. RELATIONS TO THE STOCK ROOM AND THE SHIPPING DEPARTMENT.

By Kenneth Falconer.

Mr. Falconer's articles in this series, which began in THE ENGINEERING MAGAZINE for April, are conceived on the idea that the properly equipped and properly managed factory office has profit-bringing functions extending from the time quotations are asked for on raw material until the finished goods are delivered and billed to the customer.

His first paper presented the general theory of this view; his second discussed specifically the relations of the factory office to the stores department and the shops. The succeeding paper will take up the relations of the office to the manager, and its value to the executive. The papers make a valuable complement to Mr. Carpenter's articles appearing currently. They show the possibility of money-saving organisation in the office, as he shows the value of money-making management in the works.—THE EDITOR.



IN planning a system whereby the operations of the factory office may be of the greatest benefit to the stock room and shipping department, the word "factory" must not be understood in the somewhat limited sense of a productive organization, but rather as covering all the departments of a manufacturing business, including the drawing office and pattern, stores, stock, and shipping rooms—in a word, all departments, except only the selling and the financial.

Where the technical accounting of a productive or industrial business is under the control of a staff maintained for that purpose only, and kept separate and distinct from the commercial or accounting office, the chief advantage looked for or expected is generally more efficient cost accounting. Factory accounting and cost accounting are, however, two different things, and the value of the former may be greatly lessened by limiting it to bounds which might very properly comprise the latter. In some instances the advantage of extending the technical accounting system so as largely to include the operations of the stores and purchasing departments has been recognized, but this, while a step in the right direction, does not afford a proper system of factory accounting full scope for its widest and best results. The work of the factory office, its information, records, and data, should cover all the operations of the stock and shipping rooms either past, present, or prospective, and also all transactions and correspondence with customers about orders or goods.

The objects sought by a thorough and complete system of technical accounting should be:—(1) the ultimate reduction of cost of production by means of the records and information obtained, by a close watch on the operating and maintenance expenses of the productive departments, and also by an intelligent supervision of the stores and purchasing, with the object of cheapening the raw material consumed; (2) an increase of profits by a lessening of the cost of operating all departments, including those whose expenses are not properly chargeable to the cost of production, and the adoption of such a system of information and records as will best facilitate the work throughout the entire organization; (3) an increase in the amount of sales by keeping the manufacturing departments in closer touch with the requirements of customers than can be done by either of the two alternatives usually tried, viz., affording customers (either actual or prospective) direct access to, and communication with, heads of the various departments, or, on the other hand, using the general or commercial office as a channel for such communications, inquiries, and replies.

In extending the work of the factory office to cover such a broad field it must be assumed that, to a very large extent, that department exists to represent the customer and his interests, as regards execution of orders without delay, prompt shipment when completed, and last, but very far from least, immediate notification when, through lack of full information or any other cause, delay is threatened or the fulfillment of definite or implied promises rendered doubtful or impossible. The factory office stands for the customer's interests in following orders through the shops from the time they are received until final shipment has been made and the customer notified. It stands for his interests even to the extent of seeing that the stores department, as far as possible, is always in a position to supply immediately all parts or material required for any article which the firm is liable to be asked to supply at short notice. In addition, the factory office should look after the customer's interests by ensuring delivery of goods at the date promised, failing which they should be sent out at the earliest possible moment, even at the cost of some inconvenience, or shipped by the quickest means practicable, even at the cost of an increased expense, which expense the customer should never be called upon to bear. In a word, the factory office in its relation to the stock and shipping departments should represent the customer in insisting upon just such attention to inquiries, orders, promises, and agreements as the management of the concern itself would feel fairly justified in asking and expecting under similar circumstances.

This policy carried out, and the customer always promptly replied to when inquiring concerning goods—promptly notified of any circumstance that would in any way affect his interests concerning articles being manufactured or work being done on his behalf, and immediately notified of any shipment, and in case of part shipments, of the date he may expect the balance—will soon justify the claim that the factory office may readily be a strong aid to the selling force and in itself a factor making for increase of business.

To accomplish these ends, it goes without saying that the factory office must have access to all sources of information concerning prices or purchases of stock and communications with customers; also, it must have a large control over the operations of both the stock room and the shipping department. Complete and accurate records of all quotations received or given should be kept; if a catalogue is issued and different discounts given to various classes of customers, records should be kept in such form that the proper discount to quote a named customer can be instantly ascertained. For this purpose the factory office should be provided with a catalogue interleaved with blank pages, and all current discounts marked opposite the article to which they refer, specifying to what class of customers such discounts are applicable. Whenever the name of a new customer is put on the firm's books, record should be kept of the class to which such customer belongs; the order clerk being supplied with a similar catalogue, these two books alone, supplemented by the index showing the class in which the customer's name has been placed, should be recognized as authority to quote a discount or make a price.

From the time an order is received from a customer until complete or final shipment has been made, the factory office should be in constant touch with each article being manufactured, and should know at all times the exact status of each and every order and the location of the goods called for. In the case of goods being especially manufactured this necessitates considerable detail, and to do it satisfactorily by means of bound books is almost impossible. By the use of cards, however, ruled and printed to suit the circumstances prevailing in each case, the information may be procured in such manner that it will reach the factory office almost automatically.

A card should be made out for each manufacturing order issued, and kept in a card cabinet arranged numerically until the article called for has been delivered to the stock or shipping room from the shops. It is then transferred to another cabinet and becomes a record of finished work. Form 1 is given as an example of the ruling and print-

Section of Index	Order No.
Index	For
Sub-Index	Date

Order

Wanted for

Route of Manufacture.		Transfers and Deliveries.
Drawing Office	1	
Pattern Room		
Shop A.	2	
" B.		
" C.	3	
Photo. Room	4	
Stock "		
Shipping "	5	

REMARKS:

FORM I. ORDER CARD—FRONT.

ing on these order cards; it of course must be adapted to suit special requirements. These cards must be made out by some one thoroughly familiar with the work, who indicates, in the column opposite the names of the departments or shops, the sequence in which the material must be sent from the time the order is put in hand until completion of the goods. The card which accompanies through the shops the articles being manufactured is practically a duplicate of this, thus showing the foreman of each department to which department he must send the material when he has completed his work upon it. In the example given, the order is evidently sent first to the drawing office, then to shop "A," then to shop "C." The card also shows that the management requires a photograph of the article before it is shipped.

When all or part of the goods called for by order are transferred from one shop or department to another, a transfer card, Form 2, is made out and sent with such article. The only writing required on this card is the shop letter and the order number and quantity, the date being stamped in when the card ultimately reaches the factory office. The foreman of the shop or department receiving the goods signs for them, and the card is taken back to the shop from which they have been sent; it is there placed in a box from which it is taken to the factory office at certain hours each day, and on receipt the date is stamped on it. The card showing transfers from one shop to another may then be filed behind the corresponding order card, or the information on them may be noted in the spaces opposite the shops concerned. If conditions are such that a large number of orders go through the shops and reach the stock room in a very short time, the former will be found the better plan as regards all cards excepting those showing final delivery to shipping rooms; these are noted on the order card, and in the case of delivery to shipping room the card reporting such delivery is handed to the billing clerk. If this plan is adopted 5 inches by 3 inches will be found a suitable size for the order card. If all the various transfers of the material throughout the factory are to be noted on the card, 6 inches by 4 inches will be better. Reference to the cabinet containing these cards will thus show the exact location of the goods being manufactured.

Where there is constant trouble in getting goods out in a reasonable time, it will usually be found that some one shop or department is responsible for practically all of it. In such cases the first step to remedy the trouble is to locate it. This may be effectually done by keeping all the transfer cards showing delivery to the shop it is desired to watch, with cards showing deliveries from that shop, in a tray or card-drawer,

sorted by order number and filed behind guide cards indicating the date the goods reached the shop in question and the date on which they were delivered from it. The result will be an index forcing attention to the date on which the articles have been received by the shop, the length of time they were retained, and the date they were passed on to the next department. A glance over this index each morning will show if goods are being pushed through with all the promptness and judgment possible. The question of giving to certain orders priority over others of an earlier date is one upon which the management of the factory office will find room for the exercise of its best judgment and discretion. Any promise or *implied* promise of delivery on a certain date is entered in a scribbling diary under that date; daily reference to this book and to the card index of orders will show how the various articles are progressing. If they are found to be getting behind, the card which was made out when the order was first put in hand and sent to the shop with the material is called in and replaced by a similar card of bright red color containing exactly the same information, and also the required date of delivery. Other things being equal, an order with the red card always has precedence over those with cards of the ordinary color. Care must be taken, however, not to use these "rush" cards to such an extent that they become so familiar as to be ignored.

Of the transfer cards received at the factory office, the only ones put to further use are those showing delivery to the shipping room. After being noted on the order card these are handed to the billing department, where they are kept until advice of shipment has been received and charge has been made against the customer; the date, day-book entry number, and amount charged to customer for the articles they represent are then entered on them, and they are returned to the clerk in charge of the order cards. A close watch upon the transfer cards in possession of the billing department and the dates thereof will enable the factory office to secure shipment to customers immediately after the completion of manufacture.

On receipt of transfer cards showing delivery to stock or shipping room, the order card is removed from the index of orders in progress; the cost is made up and entered on the reverse side, which is ruled as in Form 1A*, and the cards are filed away as records. When the transfer card is returned from the billing clerk the selling price, day-book entry number, and date, as shown, are entered on the order card.

* In the case of goods manufactured for stock the right-hand side of the card is left blank, or may be used as a record of prices current at date of manufacture.

Date Finished					Order No						
Entered Record Book No._____ Page											
COST					SOLD						
					Date	Quantity	Entry No.				
Material,	0	00									
Wages,	0	00									
Shop Expenses,	0	00									
Total cost in stock,			0	00							
Selling Expense,			0	00							
TOTAL,			0	00	TOTAL, . .						

REMARKS:

Examined,_____
Fact'y Acc't.

FORM I A. BACK OF ORDER CARD FOR GOODS MANUFACTURED FOR CUSTOMERS.

Order No.

DATE

FROM Shop Dept. { Shop Letter

ARTICLE and QUANTITY

RECEIVED Shop Dept. { Shop Letter

Signed.....

REMARKS

FORM 2. TRANSFER CARD.

It will be seen that Form 1 is so ruled that the article manufactured can be classified by section, index, and sub-index. All the particulars on Form 1 A being entered in a record book, the card is then filed permanently away. If the book record is arranged according to article, the card must be filed alphabetically, according to customer's name. If, however, the record book is so laid out as to keep together the records of all goods manufactured for the same customer, the card is filed according to article. The latter is the better plan, as it enables order cards representing goods manufactured for stock to be filed with those representing similar goods manufactured for customers, thus keeping all cards for the same article together. An intelligent use of variously colored guide cards for section, index, and sub-index will afford instant access to all records of costs for the same article or class of goods for any given period. This plan, besides enabling the factory office to follow the orders closely through the various stages of manufacture and to secure prompt shipment, totally eliminates all possibility of shipping any article manufactured for a certain customer and failing to make a charge. It also provides a double record of both cost and selling price of each article so manufactured and shipped, and also the cost of all articles manufactured for stock, this information being readily obtainable from the record book when looked for by customer's name, and from the cards when looked for according to class and name of article.

There are many smaller matters in which attention to a customer's interests may result in establishing relations that will ultimately secure a larger share of that customer's trade than might otherwise be had. All acknowledgments of orders received should quote the number which has been given the order, with the request that in any further correspondence that number may be referred to. When shipment is made of any article for which the invoices cannot be sent forward at once, a memorandum of quantity and route of shipment should be mailed at once; this will enable the customer to check and stock the goods immediately on receipt. These and many other little things will more than repay the time they occupy, by tending towards that good feeling between the concern and its customers which goes so far to help the traveling salesman in his work. There is many a man on the road today who could sell more goods, and sell them to better advantage, if he knew that "the house" would at once either ratify and live up to any promises he might make, or else on receipt of the order promptly advise the customer that to do so was impossible. On the other hand, a better understanding would result if travelers would make promises only condition upon approval of the management. These, and many other matters small individually, may in the aggregate seriously affect the feelings of "the trade" towards "the house" and, as a result, the volume of business done.

In a previous article I endeavored to show how a factory office, efficiently organized and properly equipped, may be of great benefit to both the stores and the shops. The plan there outlined of keeping record of the supply and demand for finished parts, and of watching the amount on hand of special articles, may with advantage be applied to many standard lines of stock. Given a factory office operated on the lines indicated, absolutely independent of both the superintendent of works and of the commercial organization, responsible alone to the executive —and with the right man in control—the results will be a smoother and more rapid working of all the departments and shops, from the pattern room to the plating room, from the foundry to the finishing shop. A close watch will be kept upon purchases, a saving of time in obtaining desired information will be effected, and the mechanical and material departments will be practically relieved of all clerical work. In addition to these results, which are in themselves direct factors of cost reduction, detailed and classified records of all costs, expenditures, and expenses will be constantly undergoing comparison with like results of previous years. It lies with the executive to obtain the greatest value from such records by their use as guides for other operations.

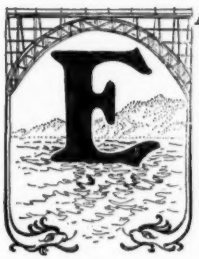
THE PROGRESS OF ECONOMY IN MARINE ENGINEERING.

By Walter M. McFarland.

IV.—ECONOMIES PARTICULARLY AFFECTING NAVAL ENGINES.

This article concludes the fine series by Mr. McFarland which began in THE ENGINEERING MAGAZINE for March, 1902. The four numbers constitute a wonderfully interesting and luminous review of one of the most remarkable developments of the last century. Marine engineering, more clearly perhaps than any other branch of mechanics, shows the commercial value of applied science. Within the period covered by Mr. McFarland's study, the fuel consumption of the steamship has been cut down until the economical marine engine of 1902 gives ten times the power per pound of coal that was given by the engine of 1825.

Mr. McFarland's first article dealt with the simple engine and the work of the pioneer investigators; his second paper covered the period of the compound engine; the third took up the development of the multi-expansion engine; in this concluding article he sums up and traces the progress to the very latest epoch—the appearance of the successful steam turbine. —THE EDITORS.

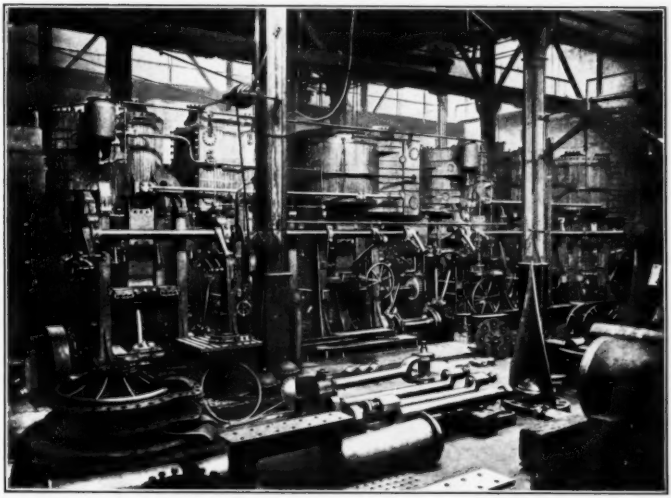


EARLIER in these articles, mention was made of the fact that the engines of naval steamers have been modified from time to time to conform to the general progress in marine engineering, but it is now proper to note a very marked difference between the conditions under which the two classes of engines operate. The merchant steamer, as an almost invariable rule, runs at a uniform speed for which the engines have been designed, so that they work constantly under maximum conditions and they can be so designed within reasonable limits as to give the highest economy under those conditions. The naval vessel, on the other hand, is designed to secure a very high maximum speed which it is expected will be called for only occasionally, while almost the whole of her cruising is done at a speed varying from a little more than half the maximum down. This means that the engines of naval vessels ordinarily develop only about one-eighth of full power, or less, although the capacity must be provided for full power. Particular stress has been laid in these articles upon the fact that even with high pressures expansion cannot be carried beyond a very reasonable degree without entailing serious loss from liquefaction, and a very little consideration will show that, altogether apart from this feature, it would actually be impossible to cut-off short enough in the high-

pressure cylinder to give the reduced power necessary when working with full boiler pressure. So long as the maximum speeds of naval vessels did not exceed fourteen or fifteen knots, the reduction in power for a cruising speed of, say, ten to eleven knots, did not entail a very serious decrease of economy, because by some reduction in the boiler pressure and some increase in the ratio of expansion it was possible to get the desired power; but when maximum speeds had risen to twenty knots and upwards, while cruising speeds were from ten to twelve knots, the problem was changed and became immensely more difficult.

Several methods have been proposed and tried for securing good economy, both at maximum and at reduced powers, to which we shall refer immediately, but it may be said that the reduced power is obtained by a reduced boiler pressure and a great amount of throttling, with some increase in the ratio of expansion. The result is certainly anything but economical, because the coal per horse-power hour with triple-expansion engines under these conditions will be in the neighborhood of three pounds. It is possible that somewhat greater economy might be obtained by lowering the boiler pressure still more, opening the throttle wider, and increasing the degree of expansion, but practical considerations make it desirable that the boiler pressure should not be reduced too low. It often happens in handling the vessel that an increase of speed of several knots for ten or fifteen minutes is very desirable. With the higher boiler pressure it is perfectly practicable to secure this, as the pressure will not be run down too low during the spurt.

One method of securing economy at cruising speeds was adopted in the U. S. S. Maine (which was destroyed in the harbor of Havana in 1898) and it was also tried in a Russian vessel about the same time. This consisted in arranging the engines with the low-pressure cylinders forward and with a coupling in the shaft so that the low-pressure cylinders could be disconnected, leaving the working engine as a two-cylinder compound on each shaft. The Maine was not in commission long enough to have a thorough opportunity for testing the economy of this method, as compared with that of using the whole triple-expansion engine, although such experience as was obtained tended to indicate that there was no very great saving. The same system was used in the U. S. S. Nashville, which has quadruple-expansion engines arranged to be worked as triple-expansion for low powers. The maximum speed of this little vessel is only about seventeen knots, and as ordinary cruising is at from eleven to twelve

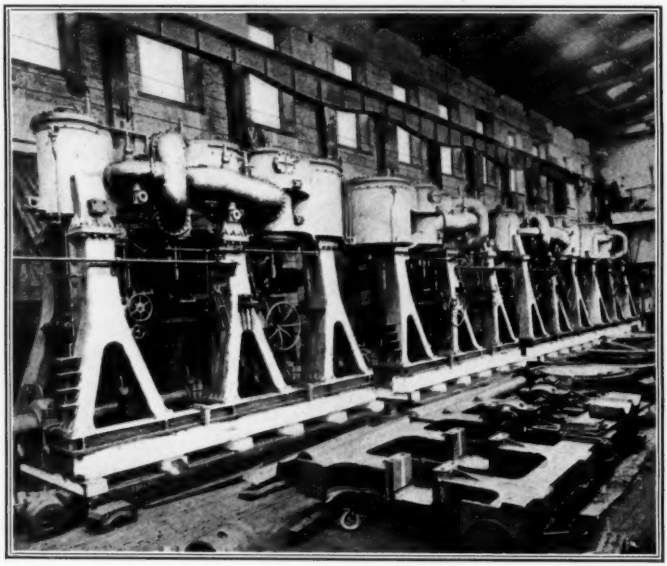


ONE SET OF TWIN-SCREW INVERTED TRIPLE-EXPANSION ENGINES FOR H. M. S. BLAKE.
Built by Messrs. Maudslay, Sons, & Field. Photo. by courtesy of John Sampson, Esq.

knots, the increased economy due to the use of the smaller engine is not very marked.

In the U. S. S. New York and Brooklyn and H. M. S. Blake and Blenheim another method is used, by which the gain in economy is unquestionable. These are all large vessels with engines from 16,000 to 20,000 horse power, and they were designed with two complete triple-expansion engines on each shaft, the idea being that at anything below half power only one set of engines on each shaft would be used, and this is actually the practice in ordinary cruising. The greater economy due to using an engine of 4,000 horse power maximum to develop 1,000 horse power, as compared with the same horse power developed from two engines with a maximum power of 8,000, is so obvious that no attempt has ever been made to compare the two. From the standpoint of economy alone this system is admirable, but the multiplication of parts, the great space occupied, and the likelihood of unequal wear when one engine on a shaft is used much more frequently than the other, are serious objections. Special objection to this type of engine was developed at the time of the naval battle of Santiago. On both the New York and the Brooklyn there was a comparatively simple coupling for connecting the two engine shafts, but it required about half an hour to perform the operation. During

blockade both the New York and the Brooklyn had been kept under half power, using only the after engines. When Cervera's fleet came out so unexpectedly, it was not deemed wise to lose half-an-hour in coupling up, so that it was possible to work the engines up to half power only. The poor work of the Spanish engineers rendered this lack of efficiency less important than it would have been had the enemy's fleet been possessed of skilled engineers; but the lesson was learned and this, added to the other objections already mentioned, renders it unlikely that this type of engine will again be used.

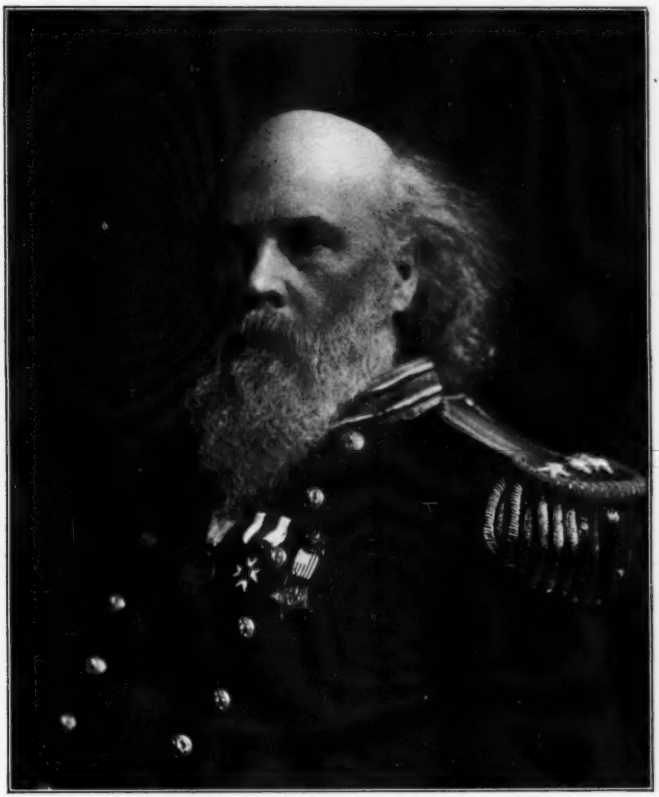


TWIN-SCREW ENGINES OF THE U. S. S. NEW YORK.

Each set is divided into two complete engines, giving full power when coupled or half power when uncoupled and the rear set only in use.

Ships with three screws are now becoming favorites in a number of the European navies, and they possess some special advantages for war vessels which would seem to render this type the best one for large high-speed ships. They were first* used in some small torpedo vessels for the Italian navy, and their efficiency at full power was satisfactorily demonstrated. A series of very careful experiments was also conducted on a French steam launch called the Carpe, which

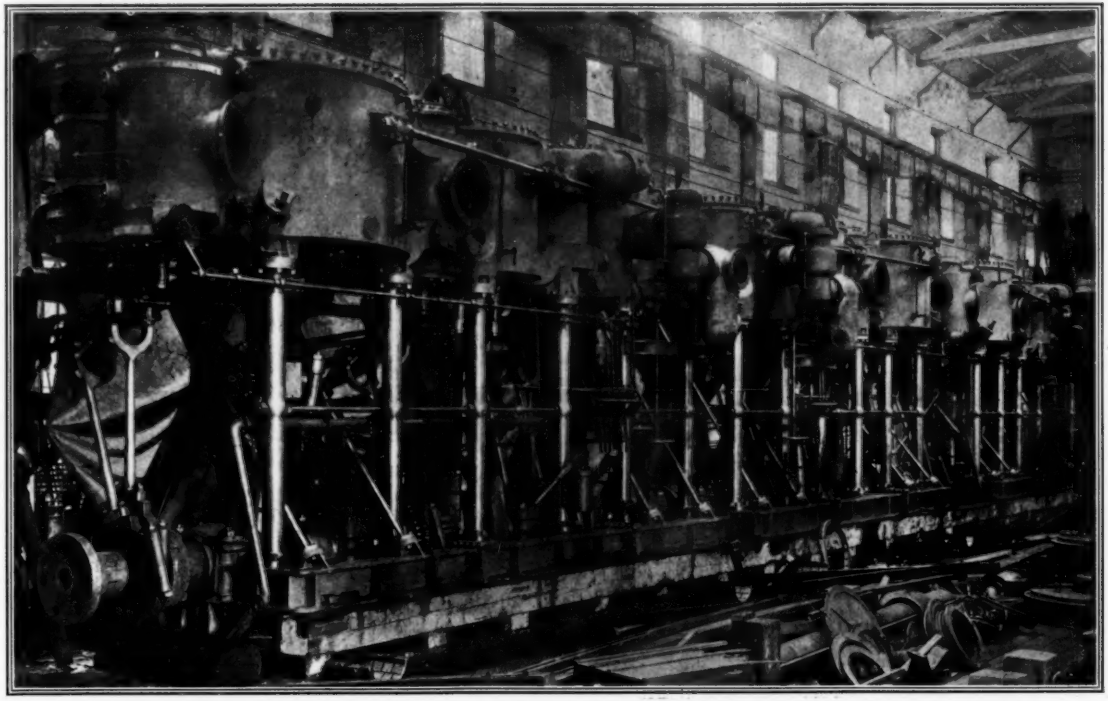
* Four screws were used on some very light-draught river steamers in the American civil war, called "tin-clads."



REAR ADMIRAL GEORGE WALLACE MELVILLE, U. S. N.

Engineer-in-Chief 1887 to date. During his administration the Department of Steam Engineering, U. S. N., adopted the uniform policy of making their own designs. Up to 1900 his administration had prepared designs for 120 ships and 700,000 horse power.

gave a great deal of valuable information to designers, and, as a consequence, the Dupuy de Lôme was built for the French navy. The Kaiserin Augusta was also built for the German navy. About this same time (1890) in the American navy it was decided to build a very fast commerce destroyer, which was wittily named the "Pirate" by Chief Engineer Towne, who was then one of Admiral Melville's assistants. When Admiral Melville considered the question of designing the machinery for this vessel he decided, after careful study, that it would be best to use triple screws for structural reasons. I



TRIPLE-EXPANSION ENGINES OF THE U. S. S. MINNEAPOLIS, IN THREE SETS, ONE FOR EACH OF THE THREE SCREWS.

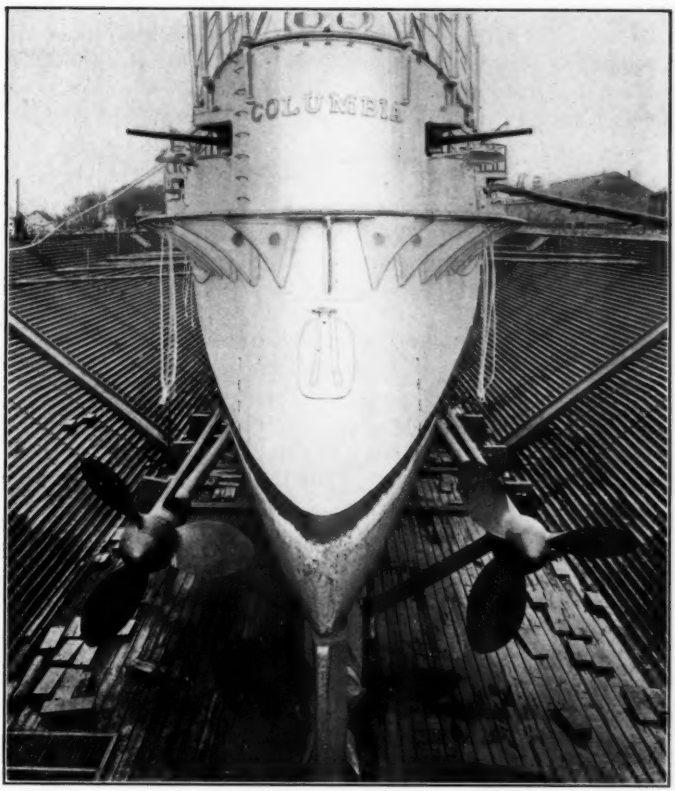
was at that time one of his assistants, and have frequently heard the admiral express himself in detail as to his views of the design. He did not anticipate any economy at maximum power, and, on the contrary, was prepared to accept as probable the predictions of professional friends of eminence that the use of triple screws would be found to require a greater expenditure of power than would be required with twin screws. It was anticipated that there would be a gain in economy at low powers from using one engine, while the screws of the two idle engines would be disconnected and allowed to revolve freely. When the Columbia was tried it was found, to everybody's great surprise, that there was actually a decided economy in the power required to obtain the maximum speed; or, in other words, the speed attained for the power developed was much in excess of what had been anticipated. Before the Columbia was tried, the second triple-screw ship—the Minneapolis—had been designed, and her trial confirmed the experience gained with the Columbia.

The fact of the unexpected relation of speed and power on these two ships is undoubted, but the explanation that it is due to the use of triple screws is not universally accepted. The British navy has never built a single triple-screw ship, and it is asserted that tank experiments have shown that the same hull when driven by twin screws would give better results than when driven by three screws. The Italian navy has likewise never built any triple-screw ships of large size, although, as already stated, they were the first to use this method for vessels of high speed. On the other hand, the French, German, and Russian navies have built and are building large numbers of vessels with triple screws, showing that they believe this type to be the best. Just why the use of triple screws has never been repeated in the American navy is difficult to say, although possibly it may be attributed to the same influence which came so near causing the battleships contracted for in 1898 to be of sixteen knots speed while all the rest of the world were building them of eighteen knots. It is well-known that Admiral Melville is an ardent advocate of their use, but his influence alone does not seem to be sufficient to secure their adoption.

With respect to the matter of economy at low powers from the use of but one engine, the results at first were not entirely satisfactory. An analysis of the records of the Columbia and the Minneapolis, and particularly of the extended trials of the Kaiserin Augusta, goes to show that it is somewhat more economical in coal required to make a given distance to use two engines rather than one This appears,

however, to be due to the fact that these ships were all built with the three engines of the same size and with the same sized propellers. The single screw under these conditions has an abnormal amount of slip, running up to more than 30 per cent. The steam economy is materially higher—that is to say, the cost of a horse power in coal is decidedly less—but owing to the abnormal slip of the propeller, the horse power required is so much increased that it more than offsets the decreased cost per unit of power. In 1899 Admiral Melville read a paper before the Institution of Naval Architects in London, in which he proposed a different arrangement of the three screws, making the center engine half the total power and the wing engines each one-quarter. While this arrangement of triple screws has not thus far actually been applied in any ships, the experience gained with the other triple-screw ships, and the knowledge of the conditions necessary for efficiency in propulsion, all indicate that this is a combination which possesses great advantages from every point of view. The propeller of the center engine would be sufficiently large to keep the slip within reasonable limits, and the conditions as to steam economy would be more favorable than in the case of the after engines of such ships as the New York, because there would be the absence of the radiation and liquefaction losses due to two sets of engines as compared with the one of the center screw. At the same time, it would be possible to use the two wing engines, which would be in exactly the same condition as the after engines of the New York—that is, half the total power—except that they would have to drag the idle propeller of the center engine. From a tactical standpoint, the three-screw ship has the enormous advantage that it would not be necessary to lose any time in connecting up the idle engines. It was found by actual test on the Minneapolis that it was possible to connect the center screw when the wing screws were driving the ship at the rate of seventeen knots, so that this is a very decided merit in this arrangement of machinery.

Another point of difference between naval and merchant steamers is in the auxiliary machinery. For convenience in handling the main engines, which is of vital importance in a war vessel, all the auxiliaries of naval vessels are independent, while in all of the smaller merchantmen, and in some quite large ones, all such auxiliaries as the air pump are worked from the main engine. Most of these independent auxiliaries, for simplicity and convenience, have hitherto been operated almost entirely by simple engines using steam with scarcely any expansion, and even where the air pumps have had compound engines



STERN VIEW OF U. S. S. COLUMBIA IN DRY-DOCK, SHOWING THE ARRANGEMENT OF THE THREE SCREWS.

By courtesy of the Wm. Cramp & Sons Ship & Engine Building Co.

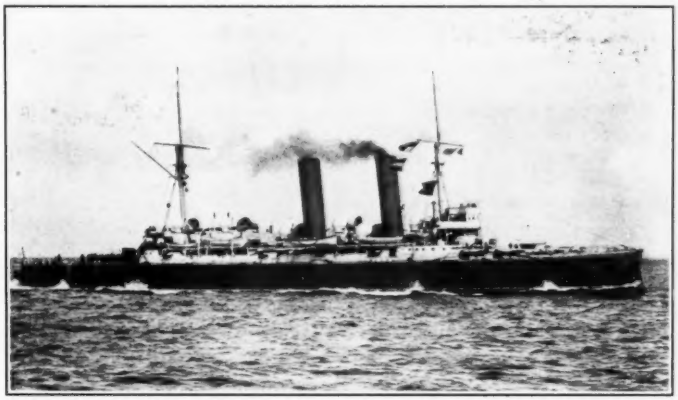
the speed is so slow that the economy is very low. At maximum powers the steam and coal expenditure for the auxiliaries is not of so very great importance, but at cruising speeds the percentage of the total coal expenditure due to the auxiliaries rises to a very appreciable figure. Professor Hollis of Harvard University, in a lecture before the Naval War College (in 1892), while he was still an officer in the navy, gave some very interesting data on this point with respect to the machinery of the U. S. S. Charleston. From these it appears that when the main engines were working at half power the coal for auxiliaries was 21 per cent. of the total coal used, while at one-

eighth power, for ordinary cruising, this percentage had risen to 34. One of the methods proposed for making the auxiliaries more economical is to deliver their exhaust to one of the receivers of the main engine, from which it can be used economically in the other cylinders, and an extension of this principle is to have the auxiliaries take steam from the first receiver and exhaust into the second, which would make them in effect a part of the intermediate cylinder of the triple-expansion engine. My attention has been called to a saving of some five or six tons of coal per day on one of the large American cruisers, due to turning the exhaust of the auxiliaries into the low-pressure receiver, when the total coal used was some sixty tons per day. Another method of securing economy is to have the exhaust from the auxiliaries pass through a feed-water heater, and this method has been adopted in some of the later ships.

So far as can be seen at present, it would appear that the simplest and most economical method of operating the auxiliaries which are actually in the engine and fire rooms is by steam, although, as has been noted, in the past these auxiliaries have nearly all been simple engines, and there may be cases where they could be compounded to advantage. For the auxiliaries outside of the machinery compartments, electric driving has been seriously considered, and in some cases has been tried with considerable satisfaction. The experience with electric transmission on shore would indicate that this method of driving the outside auxiliaries ought to give great satisfaction, both on the score of economy of operation and the avoidance of long leads of steam and exhaust pipes through living quarters and other places where they are undesirable. Thus far the electric machinery installed on board ship has been exclusively of the direct-current type, as the electric experts in the navy have been remarkably conservative. The present practice on shore for power plants is almost entirely to use the alternating current with induction motors, and these seem peculiarly adapted to the conditions on board ship. When some navy shall have been sufficiently progressive to use these motors and give them a thorough test, it seems probable that it will lead to their general introduction. The remarkable simplicity of induction motors and their ability to withstand rough usage and neglect make them particularly adapted for use in situations where their manipulation would fall into the hands of people who are not trained mechanics, as is the case with the deck force on board ship.

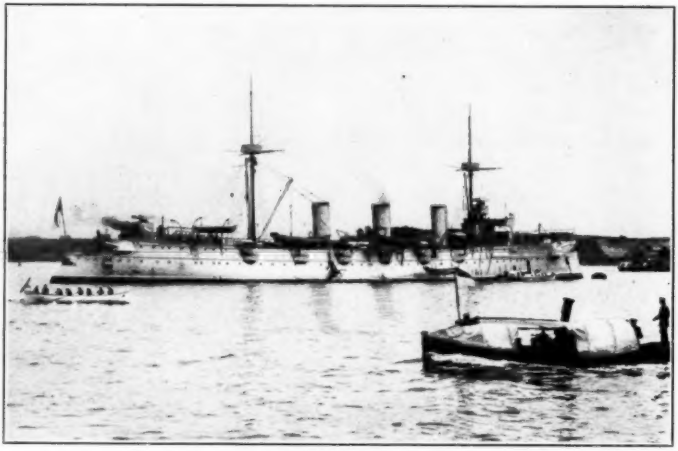
The subject of forced draught has already been discussed, but it may be interesting to note that, while with the use of forced draught

to an appreciable extent (that is to say, where it gives a material increase in the amount of coal burned) the economy of steam production is reduced, the moderate application of artificial draught, or, as it is sometimes called, "assisted draught," is really attended with a slight economy. This seems to be due to the ability to regulate the amount of air required for combustion more closely than will ordinarily be the case with simple chimney draught. In my own experience this was tested on the U. S. S. San Francisco, where it was



H. M. S. BLAKE—PROTECTED CRUISER, I CLASS, 20,000 HORSE POWER, 21 KNOTS.
The ship is 375 by 65 by 25½ feet, 9,000 tons displacement. She was built at Chatham in 1889 and engined by Messrs. Maudslay, Sons, & Field. The engines, shown on page 393, are in two complete triple-expansion sets on each shaft. Photo. copyrighted by West & Son, Southsea.

found that the revolutions could be increased from sixty to sixty-two per minute with exactly the same consumption of coal by running the blowers gently on the closed ash-pit system as against natural draught. The men enjoyed this plan, and the steam pressure could be kept much more uniform than under plain natural draught. All persons interested in the great Transatlantic steamers must have noticed that in the last ten years there has been a tendency to use funnels which are much higher than formerly. The first vessel to adopt this method of increasing the draught was the steamship Scot, of the line running to the Cape of Good Hope. This, of course, is simply adapting to steamers what had been the practice for many years on shore, where tall chimneys had been the rule. For naval vessels this has the added advantage of increased cleanliness, because with the tall funnels the particles of dust and soot are carried clear of the ship, while with the short funnels they are likely to dirty the after decks. The Brooklyn was



THE PROTECTED CRUISER KAISERIN AUGUSTA, OF THE GERMAN NAVY.

Built at Kiel, 1892. 388 by 49¼ by 23 feet, 6,300 tons displacement; 12,000 indicated horse power (forced draught), 20.7 knots. Like the Minneapolis and the Columbia, she has triple screws driven by three triple-expansion engines. Steam is furnished by eight double-ended cylindrical boilers.

the first of the American vessels to have these tall funnels, but since then it has been common practice. Roughly speaking, each additional ten feet of height in the funnel increases the draught by an amount equal to an air pressure of one-eighth of an inch of water, so that an additional forty feet of height would be the equivalent of about half an inch of air pressure. In the case of the Brooklyn it was estimated that this (half an inch air pressure) would be equivalent to an increase of power sufficient to raise the speed from about sixteen knots to seventeen and one-half knots. It should be noted that this increased height of chimney is a more economical method of getting increased combustion than the use of blowers, as it involves no attendance, no steam expenditure, and no cost for lubrication and for repairs.

A subject which is of great interest to all who study marine economy is the use of liquid fuel, and it is appropriate in these articles to discuss this subject briefly. It is well known that crude petroleum is not adapted to use on board ship on account of its containing volatile constituents, which at moderate temperatures are given off, and which involve serious danger because some of them form explosive compounds. Under special circumstances the use of crude petroleum might be permitted, but certainly on naval vessels it is entirely inadmissible. The refuse which remains after the distillation of the crude

petroleum is, however, perfectly safe, and it resembles in appearance and some properties the oil used for cylinder lubrication. This refuse has a high calorific value, giving about 21,000 thermal units per pound, which is about one and a half times the calorific value of the best steam coal. Notwithstanding the lower density of the oil, the fact that there is absolutely no waste in stowage enables about the same weight of oil to be stowed in a given space as of coal. To burn this refuse successfully it has to be sprayed, or atomized, either by a jet of steam or by the use of compressed air, and under moderate rates of combustion it gives highly satisfactory results, as the combustion is complete and there is neither refuse nor smoke. The reduced personnel required to handle boilers with fuel oil, and the ease and cleanliness with which it can be taken on board, all tend to commend it very highly. Under existing conditions there are, of course, the objections to the use of liquid fuel that it can be obtained in only a few places, and that any attempt to use it on a large scale would probably raise the price to such a degree as to make its use very much more expensive than that of coal. Some years ago one of the great American railroads was considering the use of liquid fuel for trains running through thickly populated districts. Experiments showed that, as far as manipulative considerations were concerned, it was a great success; but when the question of the amount to be used came up it was found that if this road had attempted to use petroleum refuse alone, it would have taken up nearly the entire amount available in the United States at that time.

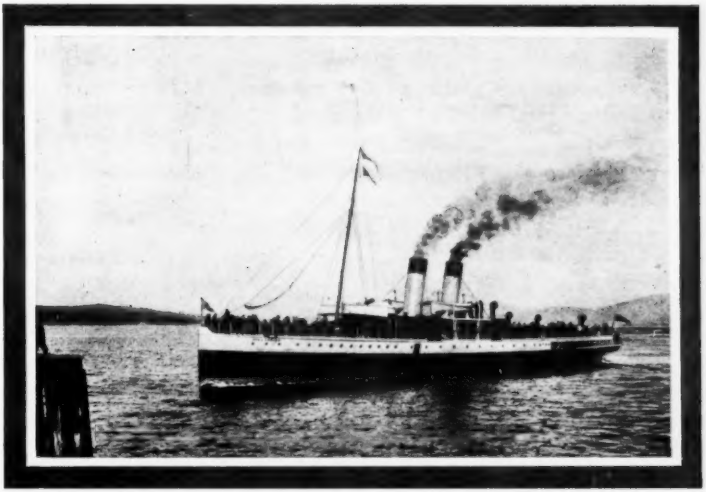
Notwithstanding these considerations, the obvious advantages of liquid fuel have made it seem peculiarly adapted to use on torpedo-boats, and during the last few years Admiral Mellville has been carrying out experiments to decide the question and to find by actual practice just what advantages would accrue. It may not be amiss in this connection to remark that, on the whole, the simplest method of spraying the oil is by the use of steam, and that this is entirely practicable in spite of the commonly held opinion that sea-going vessels could not afford to spare the fresh water required. The Italian experiments* of about 1892 demonstrated that the steam required for spraying is less than 2 per cent. of the amount evaporated in the boilers, so that evaporators to make up the necessary amount of fresh water would weigh less than the air-compressing machinery which would be necessary if air were used for spraying. The pre-

* See paper by Colonel Soliani in Proceedings of Engineering Congress at Chicago, 1893; published by John Wiley & Sons, New York.

liminary experiments on the torpedo-boat Stiletto, at moderate powers, were very promising and enabled an excellent form of atomizer to be thoroughly tested. After the close of the Spanish war the experiments were resumed upon a small sea-going torpedo-boat called the Talbot, but when the effort was made to get as good results as had been obtained with coal, a difficulty was encountered which had developed in previous experiments with liquid fuel, namely, that, as far as experience has gone, it seems impossible to get as great a power out of a given boiler plant with oil fuel as can be obtained with coal. Admiral Melville states in his report for 1900 that the highest power obtainable on the Talbot was only about three-fourths of that obtained with coal, and this last for only a short time. There was also another serious objection which had not been anticipated, namely, that at this power there was a great deal of smoke. It thus appears that, in spite of its many promising features, liquid fuel is not likely to play any large part in marine engineering. It has long been used on the steamers of the Caspian Sea, which are near the Baku oil fields, and it is quite likely that steamers which operate near the newly developed oil fields in Texas may also use it, but it does not seem possible that it can play any large part.

Any series of articles treating of marine machinery would be incomplete which did not make some mention of the new motor which is attracting so much attention, and which at last has been applied to a commercial vessel, namely, the steam turbine. This invention of the Hon. C. A. Parsons, of England, has been developed by that gentleman from a light but extremely wasteful engine to one which compares in economy very favorably with all but the most economical engines of the ordinary type. For marine purposes it was first used in a little vessel of the torpedo-boat class, called the Turbinia, in 1897, and the results there obtained in the way of enormous speed for such a small hull and great power on light weight were so phenomenal that two larger vessels—the Viper and Cobra*—were afterwards built to give it a further test. The Turbinia was only of 44.5-tons displacement, and there were three shafts driven by three turbines, each of the shafts carrying three propellers in tandem. The revolutions were 2,100 per minute, and the horse power developed 1,576. The Viper and Cobra had four shafts with two propellers on each, and the aggregate horse power developed was about 11,000. The steam pressure was 165 pounds and the revolutions about 1,050 per minute. There were two sets of compound steam turbines for driving the vessel

* These vessels have both been wrecked.



THE TURBINE-ENGINED STEAMER KING EDWARD ON THE FIRTH OF CLYDE.

250 by 30 by 10½ feet, 20.48 knots, estimated horse power 3,500. Built by Messrs. William Denny & Brothers, and engined by the Parsons Marine Steam Turbine Co., Ltd.

ahead, and special smaller turbines were provided for driving the vessel astern. The speed obtained by these vessels, which were of 370 tons displacement, was about 37 knots, which is considerably higher than the maximum speed attained by any vessel driven by ordinary engines.

It is, of course, somewhat difficult to get exactly the horse power of these engines, as the ordinary indicator cannot be used and the horse power has to be estimated from the known results in similar vessels driven by ordinary engines. In America the Westinghouse Machine Company is building these turbines for driving electric generators, and experiments have been made on some turbines of more than 400 horse power which showed a steam consumption of 18.8 pounds per kilowatt hour, which, by allowing for the known efficiency of the generators and for the usual efficiency of good engines of the ordinary type, would be equivalent to 14 pounds per indicated horse power in an ordinary engine. These results are for full-power conditions. At half power the steam consumption had only increased to 20.7 pounds per kilowatt hour, or, as already explained, 15.4 pounds per indicated-horse-power hour.

The firm of William Denny & Brothers of Dumbarton, Scotland,

who are well-known for their great progressiveness, have recently built a vessel called the King Edward, which is an excursion steamer for plying on the Firth of Clyde, and which is the first commercial vessel to be fitted with turbines. While no reports of specific tests of the performance of the King Edward have been published, the comparative statement given below of the performance of the Duchess of Hamilton and of the King Edward gives a good idea of the economy of the turbine:—

COMPARATIVE STATEMENT OF SPEED, MILEAGE, AND COAL CONSUMPTION OF THE PADDLE STEAMER DUCHESS OF HAMILTON AND THE S. S. KING EDWARD.

	Duchess of Hamilton.	King Edward.
Total coal	1758 tons 13 cwt.	1429 tons 16 cwt.
Miles run	15,604	12,116
" per ton	8.87	8.47
Number of days running	111	79
Daily average consumption	15 tons 17 cwt.	18 tons 2 cwt.
Average speed	about 16½ knots.	about 18½ knots.

The Duchess of Hamilton is one of the crack boats on the Clyde, so that her performance may be considered as representative of excellent economy for machinery of the ordinary type. We have not the data of the dimensions of the two vessels at hand, but if they were of about the same displacement the increased speed of the King Edward would justify an increased expenditure of 40 per cent. in coal. As a matter of fact, the increased coal expenditure is only about 14 per cent., thus showing a decided economy for the steam turbine.

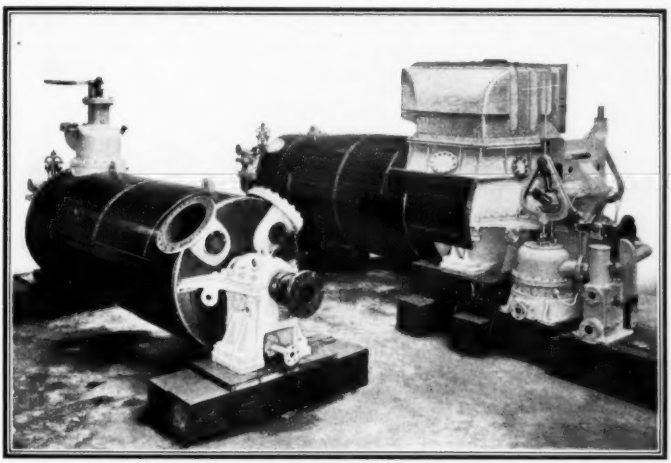
The performance of the King Edward has been so satisfactory that it has been decided to build another boat of the same type, although somewhat larger, her length being 20 feet greater and her speed 21 knots. The Parsons Marine Steam Turbine Company have also on hand at the present time turbine machinery for three high-speed yachts, the largest of which is for Mr. A. L. Barber, of New York, and is to be of about 1,400 tons, yacht measurement. The turbines will develop 3,500 horse power.

It is most unfortunate that both the Viper and the Cobra were lost at sea before there had been time to gain experience with their machinery under the conditions of regular service, but it is interesting to note that the Parsons Company are building another destroyer which will have about the same speed as the Viper but which is designed to have a superior performance to hers in regard to coal consumption at cruising as well as at higher speeds.

The advantages of the turbine are the reduced weight of machinery due to the very high rotational speeds, the reduction of vibration, the smaller amount of space required, and the relatively small

attention needed for adjustment. A further advantage is the complete immunity from any danger due to priming, or carrying over of water from the boilers, although in modern engineering this is of very infrequent occurrence. Mr. Parsons has devoted great engineering ability to the development of the turbine, and he believes that it is destined ultimately to supplant the ordinary type of engine. Whether this will prove true or not, the remarkable successes of the boats in which it has been fitted make it worthy of very serious consideration.

We have now concluded our brief survey of the growth of economy in marine engineering. The subject is one that covers so many details that it has been impossible to consider them all, and undoubtedly it will be found that some subjects have been given but scanty notice. This, however, is unavoidable in any consideration of the subject which would not be so elaborate as to preclude its appearance in the pages of a magazine. The progress which has been made in less than a century is enormous, as the figures already given of a reduction in coal expenditure from ten pounds to one pound per horse-

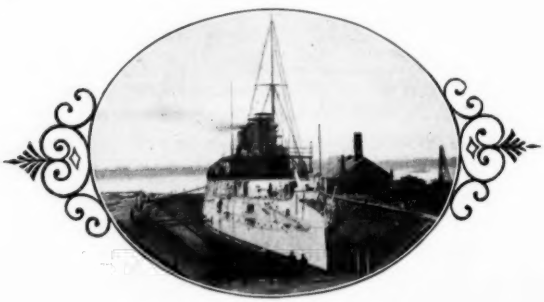


THE TURBINE ENGINES OF THE STEAMER KING EDWARD VII.
Photo by Parry.

power hour show very strikingly. We hear a great deal about the inefficiency of the steam engine when the comparison is made of the useful work done with the total calorific value of the fuel used. This, however, is a very unfair comparison, because there are natural limitations to the heat engine which effectually prevent the ratio of the useful effect to the total energy of the coal ever rising very high.

In the case of the steamers Inchdune and Inchmarlo, which have already been quoted, the thermal efficiency of the engine is 23.7 per cent. The efficiency of a perfect heat engine working between the same temperature limits is 43 per cent., so that the real efficiency of these engines, or the ratio of their efficiency to that of a perfect engine, is 55 per cent.

When we consider the way in which the more recent reductions in coal expenditure have been secured and the perfection of the machinery now used, it is certainly difficult to suggest any lines along which future increase of economy is likely to occur. Suggestions have been made by some of the talented leaders in the profession, but it has been found very difficult in practice to make some of them workable, and the practical side of marine engineering limits others. There has been a mutual interaction of land and marine engineering in the adoption of improvements, and we may expect this to continue. We cannot believe that finality has been reached, because there have repeatedly been periods when the machinery as then developed seemed to the engineers of the time as nearly perfect as that now existing seems to the engineers of today. We may sometimes be inclined to think that the geniuses in engineering passed away in the early days, but this is undoubtedly only because the general level of engineering ability and knowledge is so vastly higher than it was in the early days of the marine engine. While any such actual decrease in coal expenditure arithmetically as has occurred in the past is obviously impossible, we may still expect that there will be an increase of economy which will give a percentage decrease in expenditure comparable to what has already occurred. The engineers of the past recorded many great triumphs, and we cannot doubt that their successors will make a record which will show that professional skill has steadily advanced.



MONEY-MAKING MANAGEMENT FOR WORKSHOP AND FACTORY.

By Charles U. Carpenter.

V.—A SYSTEM OF STOCK-TRACING, INSPECTION, AND SCRAPPAGE.

Mr. Carpenter's articles began in THE ENGINEERING MAGAZINE for February, 1902, the first and second papers dealing with factory organization in its general principles and concrete examples, the third with departmentalization and systematization of the works, and the fourth with the stock department and its systems. This phase of the subject he concludes in the present number. Mr. Falconer's article on pages 386-394 is an interesting supplement to Mr. Carpenter's discussion.—THE EDITORS.

LACK of an efficient stock-tracing system is very common. Many manufacturers have become so accustomed to delays in getting finished parts to the final assemblers that they regard these delays as unavoidable, even though such delays and the consequent losses show very clearly that some very efficient system is necessary. But important as is the avoidance of delays, it is but one of the important functions of stock tracing. These functions might be analyzed as follows:

A. Putting the stock through the machine rooms, or producing rooms, in such time and with such regularity as to prevent delays to assemblers.

B. So directing the machining or producing of parts that the entire factory is working to the best advantage.

C. Keeping up of records that will show immediately, first, the location of stock in the factory; second, time required by the different departments; third, the cost of the labor together with the workman's time and name; fourth, all losses with the reasons for them.

D. Directing the transportation of all stock in the factory.

Even a slight consideration to this subject as outlined in the subheads will show its great importance, not only for getting out individual jobs, but also for efficient factory management in its broadest sense.

I strongly urge the formation of a stock-tracing department upon which the *sole responsibility for such important work is placed and to which the authority necessary to carry out the work is given.* The responsibility for getting out work on time, and the care and worry incident to securing it from the different departments at the proper time, should be taken away from the foremen entirely. It is absolutely impossible to leave such duties to the foremen to carry out and to have the factory itself run to the best advantage. The foremen's work

should be confined to their own department strictly, and their chief concern should be, and their greatest value is, securing for the firm the highest grade of work at the lowest possible cost. All possible opportunities should be given to the foremen to concentrate their attention solely upon improving their departments and their output. The large amount of worry and time consumed when the foremen's attention is given to the question of stock tracing certainly makes it impossible for them to concentrate their energies upon this most important work. Again, the foreman of a department is never in a position to know the actual needs of the entire factory. His duties should be far removed from those of stock tracer.

There is but one way to accomplish the desirable results that are so necessary to good factory management. Select as your stock tracer a man of good judgment, firmness of character, and one thoroughly familiar with the business, and place him upon as high a plane as any of the foremen in the factory, giving to him the *absolute control* of all stock in the process of manufacture. Give this tracer such authority that the foremen will understand that his requests for stock must be complied with under any and all circumstances, and then hold him responsible and accountable for all stock in the factory and subject to censure for all delays. Give to him the sole authority to secure stock from any department in the factory, either for any foreman, or for the assembling rooms. As stated in a former article, "helping one's self" should be absolutely prohibited. Put under his charge all the records for stock in the course of manufacture. Under such conditions no other man in the factory can possibly judge of the conditions and needs in the factory and the stock rooms as well as he. His records will enable him to locate all stock (as will be shown later) with more certainty and dispatch than is possible under any other system. Again, the superintendent or his assistants always know where to go for any information regarding stock, its location in the factory, and the time that they may expect to have it in the assembling rooms.

Experience has shown that this plan will produce the most desirable results. In one very large establishment connected with my experience, where there are over forty-five separate departments and an immense variety of work, the foremen follow the stock-tracer's orders implicitly in getting out the stock. They look to no one else for direction and do not lose any time "looking for work." Any foreman will tear down a job immediately to comply with the stock-tracer's orders. The motto in this factory is "Delays are absolutely inexcusable." The results are what might be expected; even the slightest delays rarely

occur, and the company receives full value for the high-priced foremen, who are thus enabled to give their close attention to the turning out of the very best class of work at the lowest possible cost.

Description of the System. Central Depots. Whatever the nature of the system, the advantages of having central depots, in which all stock not being worked upon is kept for storage and distribution, are very apparent. In this way no stock can be lost. The foreman of any department can see at a glance how much stock there is waiting for him to work upon, and it is a great aid to the superintendent in getting a clear idea of the conditions of his factory. It is also a great aid in taking inventory. These central depots can be located at any number of points, if necessary; they should contain platforms for the storage of stock, these platforms to be of the same height as the trucks used in the transportation of stock through the factory. Each department should have its own platform, and only the stock ready to be worked upon by that department should be placed upon it. These depots are especially advantageous where any system of inspection is followed.

Many superintendents, while admitting the advantages of such depots, will deny their feasibility. It is comparatively seldom that one department can take up work from another department without some hours, or even days and sometimes weeks, intervening. If the stock is allowed to stay in either department it is very apt to be overlooked or forgotten, and certainly hard to find when wanted. I maintain that the very great advantages of having this stock placed in central depots, as described, compensate many times over for the small amount of time required to haul the stock to one of the depots, put it on a platform, and then take it to the proper machine in the next department.

The stock tracer and the stock departments are so closely related that it is necessary to keep in mind carefully a few of the points brought out in the article on The Stock Department in the May issue of this Magazine. I there treated of the manner in which a perpetual inventory is kept and the methods by which the order clerk in the stock department is immediately notified when the stock in the bins has reached a point so low as to be dangerous.

Short List. It is clear that if this order clerk sends to the stock tracer each day the names of parts, together with the amounts, which are in this dangerous condition, the stock tracer will then be in the best possible position to push the proper stock through the factory and into the stock bins, provided he has the proper records by which he can promptly locate the stock in the course of manufacture. Such a report may aptly be termed the "Short List."

Stock-Tracing Card. The next record that is important is the Stock-Tracing Card. This card accompanies the stock in its entire course through the factory and has already been described in the May issue of this Magazine.

Form No. 724

Dept ..... PIECEWORK TICKET Machine No .....

Name of piece.....

Operation.....

No. Ordered	No Finished	LOSS	No. Accepted	PRICE	AMOUNT $	AMOUNT Cts.	Time Commenced	Time Finished
							Total Time	

Box No.

Workman.....

Foreman.....

Inspector.....

Check No

1-3-00-10m p—F 12

FORM I. PIECE-WORK TICKET.

The duplicate, folded behind this by the lower edge, is precisely similar except that it has the word "Duplicate" across the face.

Day-Work or Piece-Work Tickets. The form of these tickets varies greatly in different factories. Not only do the forms differ, but also the methods of recording the time consumed by the workman. In come factories this time is put down by the workman himself, in others by the clerk, and again in others a special form is used containing the hours and minutes on the sides, the time consumed being punched by the workman or the foreman. The form of piece-work ticket given herewith is very simple. The ticket for day work is so similar to the ticket for piece work that no extra description is necessary. This piece-work ticket is made out in duplicate. In a department where there is no department clerk, the workmen will soon learn how to make out these tickets. They will be checked up for accuracy in time by the foreman. In a factory, however, where the work in the different

departments is so large in amount as to necessitate the employment of a department clerk, this work can be done by him. The price should invariably be put upon the ticket by the foreman or the clerk, and some simple method adopted for checking the workman for accuracy as to the actual time consumed. The two columns headed "Accepted" and "Loss" are filled in by the Stock Inspector, the ticket being O.K.'d by him to certify that the work is accurate and that the amount is correct. The "Machine Number" represents the number of the machine upon which the work was done, this information being used in the cost system as will be shown later. This ticket is important, as from it are obtained most of the records for the Stock-Tracing and Cost Sheet.

Stock-Tracing and Cost Sheet. This is one of the vital records of this entire series of systems and deserves especial attention. This sheet will contain a full history of each lot or box of stock; it will show the full list of mechanical operations; the quantity of stock delivered to the different departments, together with the date of delivery; the date it was returned from each department; the time consumed by the workman; the piece-work price per one hundred; the machine number; the name of the department and workman. These data will be secured from the time ticket shown above. In addition to this, it will also show the number of pieces lost, give room for any explanation necessary, and also the date and amount of any stock which may be "sent ahead" of the original or main lot, in case this is necessary to avoid delays.

At first sight this appears complicated, but an investigation will show that these data are secured very easily and simply. This record, when properly filled out, will show clearly the location of the stock in the factory, whether it be in the machining departments or in the central depots. The stock-tracer's headquarters should be near the central depot and should contain the Stock-Tracing and Cost Sheets.

Some simple form of notification is necessary so that the different foremen may know what stock is in the central depot ready for them to work upon. Thus the foremen and the stock tracer are in close touch with that work which is ready for their departments, and the foremen can, without trouble or loss of time, give great assistance to the stock tracer in notifying him when they are ready to work upon the stock which is waiting for them, even though the demand for this particular stock should not be urgent. In large manufacturing establishments where an immense quantity of stock is handled, it is of course advisable that a simple notification to the stock tracer be used by the foremen. This may appropriately be called a "Moving Ticket."

Application of the System. I have already described, in the section

on Stock, how the orders for stock were placed in the factory, the stock delivered to the proper department, the foreman's receipt secured, and the stock tracer notified that the order had been placed and the stock delivered. As already shown, each lot of stock will be put into a box bearing its distinctive number; this lot of stock would have its own sheet upon which this box number would be placed, thus forming the connecting link between each box of stock and its own sheet. When the stock tracer is notified of the delivery of stock to a foreman, he makes the record on his Stock-Tracing and Cost Sheet bearing the proper box number, showing the stock has been delivered.

As will be shown later, the most efficient manner of organizing a shop requires the division of the shop into departments according to the distinct lines of machines required for the work; for instance; the milling machines would all be in one department under one foreman. Even, however, where this is not the case, a little thought will show clearly that this system can be adapted to meet such conditions.

When the work on the stock is finished in this first department (requiring either one or more operations), this stock together with the Stock-Tracing Card and the Time Tickets is taken to the central depot by the truckers. Probably the most simple means of notifying the truckers when stock is ready to be moved is by using a heavy card with the words "Move It" on them, these cards being thrown into the boxes by the workman as soon as the work is finished. As the stock goes into the central depot, the Stock-Tracing Card and the Time Ticket are handed in to the stock tracer, or his clerk. The clerk can very readily find the corresponding Stock-Tracing and Cost Sheet by the box number shown on the piece-work ticket and the cards, or the lot number on the Stock-Tracing Cards which is identical with the number on the Stock-Tracing and Cost Sheet for this particular stock.

The stock is then put upon the proper platform, the proper entry having been made on the Stock-Tracing and Cost Sheet from the time ticket, and these tickets, together with the Stock-Tracing Cards, are turned over to the inspector. The inspector checks up the stock with the time tickets by counting the stock and also inspecting it where inspection is necessary. In counting the stock the work can be very greatly facilitated by the use of a pair of counting scales as described in a previous issue.*

It is clear that it is not at all necessary to bring the stock into the central depot after each operation in the machining rooms. The frequency with which this should be done will be determined entirely by

* THE ENGINEERING MAGAZINE, May, 1902, page 196.

the conditions surrounding each case. In fact, this system can be handled even where a central depot is not used at all. In this case it will become necessary either for the inspector to go out into the machine room and check up the work for quantity and quality, or else to hold the foremen themselves responsible for these details. In my opinion, however, it is always inadvisable to have the inspector go amongst the men except in cases where absolutely necessary. It is necessary, however, that some absolute check be kept upon the workmen in such matters. One great advantage of the use of the Stock-Tracing and Cost Sheets in this case is the fact that it absolutely prevents the duplication of piece-work or time tickets on the same box of stock for the same operation. In cases where the stock is not brought into the central depot, the O.K. of the stock-tracer's clerk should be required on all piece-work or time tickets, in addition to that of the inspector, so as to insure the impossibility of the duplication of tickets.

As the stock is taken into other departments, by order either of the foremen or of the stock tracer, this fact is recorded on the Stock-Tracing and Cost Sheet. In the example shown on the sketch (form No. 2) this stock has already gone through the operations of punching and striking and it is now delivered to the next department for shaving operation. When the record is completed for any one operation, and there is no record of delivery for the next operation, this fact indicates that the stock is in the central depot. In cases where a central depot is not used, it indicates that the stock is waiting in the factory for the next operation. Thus, as the stock goes from one operation to another throughout the factory, the records of its movements can be shown on the records of the stock-tracer's office at all times, through the simple expedient of referring the time tickets to him.

Of course the details of applying such a system as outlined must be worked out for each individual factory. It is my intention to give only the fundamental ideas of these systems so they can be adapted to meet the requirements of any line of business. This stock-tracing system, together with a simple and efficient piece-work system, will give all the necessary checks for any business. That stock should be counted often in its course through the factory so as to insure that the men produce what they are paid for is, of course, very necessary. It is also self-evident that stock which must be produced with great accuracy should be carefully inspected. When either counted or inspected, the workman's time ticket, as already indicated, should be O.K.'d by the counter or inspector for accuracy of the parts.

This time ticket should then be sent back to the stock-tracer's office,

Operations	Quantity	Date Delivered	Date Returned	Time Consumed		P. W. Price Per Hun.		Department	Machine No.	Workman	No. Pieces Lost	Sent Ahead		Remarks
				Hrs.	Min.							Date	Amount	
Punch	*1,000*	*4/23*	*4/25*	*9*	*30*		*.07*	*Punch*	*1140*	*John Smith*	*10*			
Strike	*990*	*4/26*	*4/26*	*2*	*15*		*.02*	"	*120*	*E. Barr*				
Shave	*990*	*4/27*												

Box No.....

Date.....19.....

Name of Stock.....

..... Lot No.....

.....Pieces Received by.....Date.....Entered on Invoice Card.....

STOCK TRACING AND COST SHEET.

In the form as prepared for actual use, the number of horizontal lines is larger, allowing for any probable extension in the number of operations.

the original and duplicate of the time ticket torn apart by him and properly stamped with the date. The original of this ticket will then be sent to the piece-work department, which will make up all the vouchers for pay for the piece-workers. The duplicate of this ticket will be returned to the department from whence the original ticket came.

In large departments, where it is impossible for the foremen to keep in close touch with all the details of the work, it is necessary that these duplicate tickets be entered in a book to the credit of the workman. These duplicates are then turned back to the workman, who can thereby note if there have been any rejections of stock for which he will not receive pay. In cases where an unusually large amount of stock has been lost, it is advisable to notify the man immediately concerning this loss, not waiting until the duplicate ticket is returned to him. The detailed description of this part of the system comes properly under the piece-work system, but is introduced here briefly so as to give a general idea as to the course these time tickets take.

In considering any system of stock tracing, inspection, and piece work, it must be borne in mind that one absolute necessity is the providing of perfect checks upon the workman, and if possible the inspectors, at all points. In my experience, I have found many systems which were considered perfect, which, however, upon a close examination, proved defective. In many cases the workmen were taking advantage of these defects.

Inspection. It is hard to convince the average manufacturer that it will pay him to employ a number of high-priced men to do nothing but inspect the work done by other men. His thoughts are concentrated upon the fact that his payroll for these inspectors, who are producing nothing, is but a constant expense, and he can not realize the very large economies which their work, if efficient, will bring. I have seen many cases, however, in which a simple and thorough system of inspection of parts in the process of manufacture would have brought large profits to a concern at that time operating at a loss. The advantages of having accurate tools and gauges and a first-class system of inspection are so great that they can not be discarded lightly by any manufacturer. Workmen generally will do no better work than they are required to do. Any system of inspection must be thorough, and the limits given to certain work must be adhered to uncompromisingly. The slightest show of weakness on the part of the inspector will be noted immediately throughout the manufacturing establishment and the consequences therefrom are what might be expected. The elimination of defective parts by an inspector, important as it is, is only of

minor significance when compared to the general effect. It would astonish the average manufacturer to find how soon his workmen will come up to any standard set by the inspection department, and how very small the loss will be, no matter how close the limits may be held. I speak from the experience of a concern where many parts are held to within five ten-thousandths of an inch and in some cases even less.

Authority of the Inspectors. The inspector's authority to reject stock should be unquestioned, and the superintendent should never, unless under the greatest provocation, reverse his decision. The advantages of an efficient inspection department might be thus analyzed:

First; it instils into the minds of the workmen the fact that the work they produce must be up to a high standard, and that if it be otherwise it will be thrown out without question, at their loss. This one feature will result in very marked improvement in the character of the work.

Second; imperfect parts are eliminated before the stock goes to the assemblers. The elimination of filing and fitting of parts in the assembling room will result in economies that are in many cases startling. A walk through the assembling room of the ordinary manufacturing establishment, by one who closely observes the assemblers at their work, will convince him that if conditions were changed so that the parts would come to those assemblers so they could be put together without fitting or filing, the cost would be reduced very materially.

Third; an inspection system provides protection to the company, in that the workmen get pay for good work only and are properly charged with that which is defective. The great importance of this from an economic stand-point can be readily appreciated.

Fourth; the fact that the parts are practically duplicates of each other will result not only in ease of assembling, but also ease of repairs. It will also mean fewer repairs, inasmuch as much less fitting in the assembling room is required.

Consideration will show that a system which will bring such results will produce large economies in every direction, but principally in the assembling rooms. The parts can be assembled so much more accurately and so much more quickly by the assemblers that the saving in these rooms alone will pay many times over for the original cost of inspection. Again, the machines, whatever they may be, will be much more accurate.

The inspectors should be provided with the best possible gauges for all stock which must be accurately machined. In many cases it is not necessary to employ an elaborate system. However, it will be

found by experience that the inspection of parts is the key to cheaper production. Of course, on parts requiring accuracy it is necessary that the men in the machine rooms be provided with gauges which are exact duplicates of those in use by the inspectors. It is important, too, that in all cases there should be some regular system by which these gauges, both in the machine rooms and in the inspector's care, will be examined carefully at certain intervals and compared with the tool model to ascertain whether or not they have become worn. Many firms have suffered large losses through neglect of this small but very important fact. The tool models should be kept in the possession of the head tool maker, or some one especially appointed for that work. A card index of all tools and gauges outstanding throughout the factory should be kept by the tool maker, and he should determine how often a tool or gauge should be examined to insure its being in the proper condition. Then, he should arrange these cards so the proper ones are brought to his attention each day for examination. Accuracy of the tools and gauges can in this way be very easily insured.

Scrappage. It is unnecessary to go into detailed description of a special plan. The details of a system of scrappage can be very readily worked out by any one. There are, however, a few general rules which should be adhered to in the institution of any system. It must first be generally understood throughout the factory that stock can not be got out of the factory without passing through the hands of the inspectors. It is very easy to accomplish this when the stock movers, or truckers, are placed under the control of either the stock tracer or the inspectors. The inspectors should never scrap stock from any department without a full explanation from the foreman of that department as to what is broken up and why it has been done. It is important that this one rule be adhered to, as if the attention of the foreman is not called to this, waste will occur.

Inexpensive printed forms that will make this work much easier and simpler can be readily got up to meet the conditions of any business. In many cases it is advisable to hold the scrap stock in the inspection department and to call the superintendent's attention to the amount of waste that is going on. Reports should certainly be made by the inspectors at least once a month, showing the amount of stock scrapped by each foreman, together with his reasons. The effect of this upon the foreman will invariably be beneficial. If the foremen realize that they are liable to censure for the excessive amount of scrap coming from their departments, they will soon give this their personal attention.

A trial of a simple system of this kind for a few weeks will prove to any manufacturer that the unnecessary waste in his factory is astonishing. In large establishments, especially, it will be found very advantageous to separate the different metals which are usually mixed in the scrap. A very much higher price can be secured for scrap metal when it is separated in this manner than if it is mixed together.

Stock Transportation. The effective and quick transportation of stock around a large factory has become an important problem. Of course, in handling large work, the system of cranes is almost universally adopted. However, I treat here of the handling of a large quantity of small parts. This work should be put in charge of an organized body of men with an efficient man in charge. This organization can be made particularly effective where there are central depots and where the stock transportation is put directly in charge of the stock tracer.

This force of men (truckers) will deliver stock to all departments in the factory as it is called for, and upon their returning to the central depot they will be expected to bring in the stock that is on the machine-room floors already finished. The fact that this stock is finished is indicated by "Move It" cards, already described, which have been thrown into the boxes by the workmen. In cases where stock is urgently needed, or can be used to great advantage, another card, which may be termed the "Special Rush" card, is used. This card should be about 4 inches by 5 inches in size, and be made of very stiff tarboard or tin, the words "Special Rush" being printed in very striking colors.

The stock tracer alone should have the authority to put these special rush cards in a box of stock, as otherwise so many of them will be used as to make them of no value. A rule should be made to the effect that, whenever stock is sent to a foreman with a special rush card in it, this is equivalent to a positive order that this stock must be got out immediately. It should also be understood by the truckers that under no circumstances should boxes of stock with these special rush cards in them be allowed to remain on the machine-room floor after the work has been completed. The foreman of each department should of course make it his business to see that stock when finished is pushed out of the department as soon as possible, and he should notify the stock tracer immediately should he desire stock taken away.

Experience has shown that this system has decided advantages over that of allowing any foreman to have his own gang of truckers. This is, in fact, the centralization of the trucking force throughout a factory, placing it under the charge of the man most competent to handle this part of the business—the stock tracer.

EDITORIAL COMMENT

THE horror at Martinique is so frightful—so overwhelming in its proportions—that it has almost blotted out of remembrance the closely preceding earthquake disaster at Guatemala. There is possibly no physical connection between the two disturbances, but there is a very close logical connection between the lessons as to seismic possibilities they afford and the decision yet to be made as to the route of the Isthmian canal.

In the editorial pages of this Magazine for June, 1900, enumeration was made of three great geophysical difficulties in the way of successful construction and operation of the Nicaragua canal, the second being "The menace of earthquake disturbance sufficient to imperil not only the stability but the very existence of a construction so dependent on dams, embankments, locks, and cuttings." This consideration might properly have been placed first, except that it was potential, while certain others are ever present. How utterly overwhelming and irremediable the ruin would be is now vividly apparent. Congress may well pause to consider this phase of the question very thoroughly before taking any action which would expose to such destructive forces the hundreds of millions invested in an Isthmian canal, the countless and measureless interests which would become dependent upon its stability.

* * *

THE fear of earthquake or volcanic overthrow of a Nicaraguan ship canal is no vision of an over-fearful imagination. In the Review of the American Press in this Magazine in June, 1901—just one year ago—an abstract was given of a series of studies of this phase of the subject, made by an able French engineer, M. Bunau-Varilla. It is pertinent to quote anew a brief statement of his conclusions.

* * *

First, as to actual topography:—

"In the very center of Lake Nicaragua is a volcano in constant activity, the Omotepe, whose last great eruption occurred in 1883. Between this and the volcano Coseguina we find a series of volcanoes in recent or continuous activity—the Hell of Masaya, on the shore of Lake Nicaragua, the celebrated Momotombo, on the shore of Lake Managua, the volcano of the Pilas, which was born in 1850, the Santa Clara, the Zelica, the Nindiri, being the best known of them."

Second, as to manifest seismic tendencies:—

"1. The Lake Nicaragua is one of the three lines of least resistance in Central America, which are a site of election for great seismic disturbances. It is the line of depression between the Costa Rican volcanoes and the Nicaraguan, and plays the same part as the other two (the bay of Fonseca, which is a volcanic lake characterizing the depression between the Nicaraguan and Salvadorian volcanoes, and the Lake Pacayan, characterizing the depression between the Salvadorian and Guatemalan volcanoes). These two last lines of least resistance have been the site of the most terrible convulsions, owed to the Coseguina for the former and to the Fuego (Fire) for the latter.

"2. The underground fire is going south, and increasing in Nicaragua. From the figures given by M. Bertrand I calculated that before the nineteenth century, out of all the great explosions or earthquakes recorded, 45 per cent. belonged to Guatemala, 35 per cent. to Salvador, and 20 per cent. to Nicaragua, whereas

in the nineteenth century only 30 per cent. belonged to Guatemala, 45 per cent. to Salvador, and 25 per cent. to Nicaragua, showing an evident tendency to a displacement of the activity southward and an increase in Nicaragua.

"To justify these figures one can say that several volcanoes became extinct in Guatemala, and that none was extinct in Salvador or in Nicaragua, but, on the contrary, that two were born in Salvador, Izalco, in 1770, and Ilopango, in 1880, and one was born in Nicaragua, that of Las Pilas, in 1850."

Third, as to recorded experience:—

"The explosion of the volcano Coseguina in 1835 lasted 44 hours; the noise was heard at a distance of 1,000 miles; the ashes were brought 1,400 sea miles by the winds; * * * during these 44 hours the volcano ejected every six minutes a volume of stone and ashes equal to the total volume of the prism of the Nicaragua canal."

And even as the words are being written, report is received that the volcano Momotombo, on Lake Managua (which is an extension of Lake Nicaragua) has been "discharging showers of ashes accompanied by great quantities of smoke and a rumbling noise. This was followed by an earthquake that destroyed the docks at Momotombo and the terminus of the railroad running from the lake to Corinto on the Pacific." It need scarcely be pointed out that a canal supported by dams, embankments, and locks is immeasurably more vulnerable to seismic attack than even docks and railway structures.

* * *

THE appendix to the Canal Commission's report contained the statement that "in the northwestern part of Nicaragua, slight earthquakes are frequent. Scarcely a month passes without one or more being noticed." In Panama, on the other hand, to quote M. Bunau-Varilla, "there is no volcano within a distance of 180 miles." The isthmus there has not been modified since the quaternary period. Its "rare and small seismic vibrations come from distant centers."

Here again new data just to hand strongly reinforce the older evidence. Gen. Henry L. Abbot, whose article in our February issue was so widely quoted, has just contributed to the *Evening Post* a summary of a year's seismographic observations in Central America—probably the first systematic, scientific comparison yet made of the two routes in this particular. Briefly, the Panama record for 1901, taken in the city of Panama, showed five movements—one "sensibly felt," three "very light tremors," one so slight as to be questionable. All came from the east or northeast. The disastrous Guatemalan earthquake of April last produced not even a tremor at Panama. But at San Jose de Cost Rica, the observing point near the Nicaraguan route, *fifty* seismic movements were recorded during the year, twenty-seven being classed as "shocks," seven as "strong shocks," while two others, though defined as "light shocks," were sufficient to cause people to run out into the streets. And General Abbot points out the grave significance of the fact that the disturbances in nearly every case "came from the projected canal route."

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SURELY, with the very slightly disturbed Panama region as alternative, it would seem nothing but madness to locate the Isthmian canal on the Nicaragua line—a line of manifest crustal weakness, destructively shaken by earthquake throughout almost its entire length as recently as 1844, and marked at its central and key point by the smoking volcano Omotepe in Lake Nicaragua, whose last great eruption occurred only nineteen years ago.

REVIEW OF THE BRITISH PRESS

Locomotive Performance.

THE subject of the comparison between engines of British and foreign make has been going on for many years, and will doubtless continue, but at the present time it has been brought conspicuously to the front because of the report which has been made to Lord Cromer by Mr. Trevithick concerning the performance of British, Belgian, and American locomotives in Egypt.

We have no intention at this time of going into the relative merits of the various engines as regards their nationality; the question of the performance of a piece of machinery certainly may be judged on its merits, without permitting the question of its origin to enter at all. Rather may we be permitted to call attention to the fact that the question of the cost of railway transport should be taken as a whole, and that each element should be considered as a part of that whole and not as an isolated question.

Thus, in comparing the locomotives under consideration the points taken into account were: price; time required for construction; quality, including cost of repairs and consumption of oil; and consumption of coal. Calling the various engines under consideration by the countries of their origin merely as a means of identification, the result of the report is broadly, that the British engines consumed less oil and coal, and required less for repairs, but were of higher first cost, and slower in delivery. The Belgian engines cost somewhat less, and were economical of fuel, but needed more repairs, while the American engines were decidedly lower in cost and quicker in delivery, but the most extravagant in fuel consumption, besides requiring much repairing.

These are interesting points, and an examination of the detailed construction of the various locomotives should make the causes of these differences in performance and other qualities evident, independently of the geographical location of the works in which they were built. At the same time it appears that there are some other points regarding the locomotives which should be taken into account before their actual adaptability for the service required can be intelligently determined. The true value of a locomotive is known only when its life history has been recorded. Like a human being it is brought into the world and prepared for its work at a certain cost, and during its life a certain ascertainable expense is incurred in its maintenance. Like a human being also, the value of its life is measured, not by the time of its existence, but rather by what it accomplishes during its working life. There were patriarchs in days of old whose entire cen turies of existence did not accomplish one-hundredth as much as has been given to mankind in the few years of a Hertz or a Maxwell; and there are engines in South Kensington to-day whose age is interesting out of all proportion to their performance.

As M. Sauvage has pointed out elsewhere in this issue, there are two sides to the account, and on one of these only we have entries from the data above mentioned. On the other side should be entered those much more difficult to obtain, as the distances and the loads hauled, together with the speeds made, grades overcome, and, in general, the income produced. Above all it should be remembered that a locomotive, again like a human being, has not an indefinite life, which can be usefully prolonged by continual patching, repairing, and replacement of parts. Far more important than either repairs or fuel consumption is the total amount of paying work to be gotten out of an engine during the limited life period which, in the course of mechanical progress, it should be permitted to have. It has been naively said of these Egyptian engines, that after the lapse of ten or fifteen years the defective parts of the Belgian and American engines will have been replaced

by parts of British make and that they will then be equal to each other. By the expiration of fifteen years all three groups should have served their time and be lying in unrepaired equality on a common scrap heap, their work being done by successors of admitted superiority.

The engine which hauled the World's Fair Flyer from New York to Chicago in 1893 in record time is to-day doing occasional duty as a switch engine on some unrecorded siding, although not yet ten years old, and this in the ordinary course of railway progress. When it is thus realised that the entire value of an engine is to be charged to the depreciation account in ten to fifteen years, the relative proportion of repairs to service becomes an almost negligible quantity.

It is surely time for engineers in all parts of the world to recognize the fact that the variations in design and construction in such an important machine as a locomotive are the result of its environment, and that each type can do its best only under the conditions in which it was produced. When a locomotive is put to its maximum possible duty and the coal consumption per ton-mile recorded, we have some measure of the energy in the fuel which it is capable of converting. When against this is charged a depreciation of 7 to 10 per cent. per year, as well as its full share of all the operative charges of the railway system in which it is worked, it will be seen that the fuel consumption per engine is hardly a safe basis on which to make a comparison of performance.

It is interesting to note that while American engines are stated to consume nearly twice as much fuel as those of British build, the cost of merchandise transport is more than four times as great in England as in America, so that the superior fuel economy of the engines can scarcely be taken as a correct index of the cost of railway transport.

The fact is clear that no useful conclusions can be drawn from the performance of any detail of a great and highly organised system like a railway company, but that the whole system, with all its involved and correlated departments must be considered if useful or even intelligible results are to be expected.

The Future of Naval Warfare.

We have referred more than once in these columns to the importance of engineering in warfare, both on land and sea, and have ventured to express the opinion that the warfare of the immediate future would be carried on by engineers and by engineering methods alone, to the practical exclusion of the antiquated methods of the existing military establishments. We now have an interesting paper presented before the Institution of Naval Architects by Mr. W. Laird Clowes, upon recent scientific developments and the future of naval warfare, which concurs with these views in many points.

One of the strongest points made by Mr. Clowes is the neglect, or even unwillingness of those in authority to consider valuable inventions which are submitted to them.

"At a time like the present, which is one of extremely rapid scientific progress, it is especially incumbent upon us not to neglect, even for a single unnecessary day, any device which may possibly enable us, either in peace or in war, to defeat our rivals by honourable means. Scientific discovery tends ever more and more to obliterate the significance of those physical and moral differences which anciently rendered one race superior to another; and brain and thought are already more potent factors in the world than mere muscles and animal courage. Moreover, we know from experience that to-day, or to-morrow may produce a complete revolution of method in almost any of our processes.

"We ought, therefore, never to sleep, save, as it were, with our ears and eyes open. Yet, strange to say, the amount of practical attention which we give to new machinery and appliances is often, I am afraid, inversely proportionate to the novelty and ingenuity of the device in question. We are too prone, when examining new inventions, to admire the cleverness displayed in them, and then to reject them, wholly and finally, for one of two reasons, both of which are in reality quite inadequate.

"One reason frequently alleged is that the invention has yet to be brought to absolute perfection, and that, pending its complete evolution, we may safely neglect it. The other reason is that the machinery or apparatus is too delicate or complicated for use by the class of workmen who are ac-

customed to handle the appliances which the new apparatus would supersede. The evils resulting from such an attitude, which is characteristically a national one, are twofold. On the one hand, we snub and starve the inventor, and possibly drive him elsewhere in disgust; on the other, we make the far more dangerous mistake of assuming that the tide of technical education will not rise elsewhere so long as we choose to batten it down in our own little hold. What we ought to do is, surely, in the one case to take up promising inventions, and, turning them over for development to the brightest intellects at our command, to enjoy the exclusive profits of them as soon as they shall be practically perfect; and, in the other, to educate our men up to the point of being able to use delicate and complicated appliances instead of rejecting the appliances because our existing men are incapable of handling them."

Recognising that the fundamental principle of naval warfare is now, as it was in Nelson's time, to have at the right spot, and at the right moment, a fighting force superior in *personnel*, as well as in *matériel* to the force of the enemy at the same time and place, it is still important to realise that this end must be obtained to-day by different means than those of Nelson's day. Speed, above all things, is the controlling factor to-day, and speed is a matter entirely in the control of the engineering department of naval warfare. Speed is the soul of all effective combination for offence, and is also a very effective means of defence against certain weapons, such as submarines, which can hardly perform effective work against a mobile enemy.

The use of wireless telegraphy, protected against tapping by suitable tuning, and the employment of proper cipher codes, may double or treble the offensive usefulness of speed, and here again it is the engineer who is required and not the seaman.

Next to speed comes the question of rapid and accurate gun fire, and although gunnery has been arbitrarily appropriated by the executive branch, it is really a matter of engineering. The gun is a most complete piece of machinery, and there is no doubt that some of the modern range finders are altogether superior in accuracy and efficiency to the most experienced eye and judgment, certain executive officials to the contrary notwithstanding.

The whole question is not in the development of engineering appliances in warfare, but in the supply of proper men to handle them.

As Mr. Clowes well says:

"Our best available tools are rapidly getting beyond the effective control of our best available men, and the real lesson of the situation undoubtedly is that if we would properly utilise all the resources which science has placed, and will presently place, at our disposal for the prosecution of naval warfare, we must greatly improve the scientific standard of the *personnel*.

"It is significant that Lord Charles Beresford, without committing himself to any expression of opinion as to the merits of certain types of water tube-boilers, has hinted his belief that many of the breakdowns of those boilers may possibly be attributable, not so much to defects inherent in the boilers, as to the incompetency of the working staff, an incompetency due to lack of training and experience, and perhaps also to short-handedness."

The dire foolishness of all this business appears in the fact that it is assumed to be necessary to take executive officers, and by some sort of hocus-pocus convert them into capable and competent engineers upon the moment. Apparently the executive branch must be taken care of, though the navy fall hopelessly behind its possible and probable opponents. Boer farmers seem to have made good soldiers and formidable enemies, though they never saw a military academy, and are profoundly ignorant of the manual; but their military effectiveness depends upon the fact that they are "men who can shoot and ride." The modern battle ship must be able to shoot and steam, and these features being provided it matters little whether there are executive officers aboard or not.

Overheating of Boilers.

OVERHEATING is well known to be one of the most frequent sources of injury to steam boilers, and hence the paper of Mr. C. E. Stromeyer, presented before the Institute of Naval Architects upon the distortion of boilers due to this cause demands notice, since the experience of the author

renders him especially well qualified to speak upon the question.

Considering first clean boilers, Mr. Stromeyer examines the question of the degree of forcing which will cause boilers of otherwise satisfactory behaviour to show evidence of distortion from heat. Fires may be forced almost any rate of combustion, but it is not the hardest-forced fire which is the hottest, since with very high rates of combustion the products which leave the fire consist almost entirely of carbonic oxide and nitrogen, and the temperature is relatively low. When complete combustion is attained, however, it is shown that the maximum temperature attainable with a coke or anthracite fire is about 4,000 degrees F., the location of the hottest portion depending upon the arrangement of the furnace, and the management of the air supply.

Two effects of high temperature upon the metal are to be considered, one the internal effects, due to the temperature gradient in the thickness of the metal, and the other the action of the pressure, modified by the distortion caused by change of shape. These are examined both for internally and externally fired tubes, and it is shown that an internally-fired furnace of 40 inches internal diameter, although clean and free from scale or grease, will be distorted so that the horizontal diameter will be about 41 in., and the vertical 39 in., a change of 2 in. From an examination of the stresses in water tubes, it appears that when the thickness is less than ⅛ inch the tube diameter must be made smaller than 6.4 in. on account of stresses due to internal pressure, while for greater thicknesses the diameter has to be reduced on account of stresses caused by the temperature gradient in the metal; this is therefore a maximum diameter for either case.

In considering the effects of scale and grease, Mr. Stromeyer assumes that scale of 1/10 in. in thickness offers as much resistance to the passage of heat as does a film of grease 1/100 in. thick, or a plate of steel 10 inches thick. Taking into account these various rates of heat transmission, Mr. Stromeyer computes that for a clean furnace plate ½ in. thick, transmitting 20 evaporative units per hour, there will be a difference in temperature of 10°F., between the furnace and the rest of the boiler, while for a transmission of 140 evaporative units the difference in temperature will reach 70°F.; these differences producing expansion stresses of 1,700 pounds and 12,000 pounds per square inch, respectively. With 1/10 in. of scale the temperature gradients are so increased that the stresses in the metal would reach 60,000 pounds, and 350,000 pounds for the same evaporative units, providing the plates were rigidly held. Such stresses are of course impossible, and something must yield. In the case of furnaces, the front plate may be pushed out, while in water-tube boilers the tubes are bent, and the necessity of providing some degree of elasticity in the construction is evident.

Mr. Stromeyer gives some interesting computations, showing the very short time required for metal to become overheated under the conditions which may occur in steam boilers, and emphasises the important matter of the reduction in strength which takes place under even moderate overheating.

Concerning the influence of grease in boilers, some curious facts have been developed. There is no doubt that the introduction of grease will cause furnaces to bulge and tubes to burst, but at the same time an examination of the injured parts shows grease to be absent from them, although present in other parts of the boiler. It also appears that grease has a more marked effect in otherwise clean boilers than in those covered with scale, and it is far more injurious with forced than with natural draught. Comparing the relative resistance to heat transmission of scale and grease, it seems as if there must be some other reason for the injurious action of thin films of grease, and it may be that the grease undergoes a chemical change which renders it a far worse conductor of heat than it was. Various theories have been advanced to account for the contradictory phenomena. Mr. Stromeyer himself suggests the influence of retarded ebullition, and the action of hammer-blows, but this view, as he himself admits, does not agree with the observed fact that collapses due to grease occur gradually and not suddenly.

Nevertheless the injurious action of grease in boilers is fully established, and this alone must be appreciated and the explanation

sought in the meantime. At least the fact is emphasised that boilers should be kept clean, and that the best way to keep them clean is to put nothing but clean water into them. Scale can be kept out by using surface condensers or purifiers for the feed water, and grease con be filtered out or separated. These two points attended to, it only remains to adopt such designs as shall avoid undue thicknesses of metal in the highly heated portions, and provide means for permitting unequal expansion and contraction without producing excessive stresses. Under such conditions distortion may be kept altogether within reasonable limits, and accidents from this source practically eliminated.

The Efficiency of the Nernst Lamp.

NEARLY a year ago we noticed in these columns the progress which has been made in connection with the development of the Nernst lamp in America, and now we have the valuable paper by Mr. R. P. Hulse presented before the Institution of Electrical Engineers, giving the results of tests for endurance and efficiency upon some of the 1902 model lamps now on the market.

The general construction of the Nernst lamp is now well understood, the illuminati..g element being a pencil of incandescent earths, similar in composition to the material of the Welsbach mantle, this being rendered a conductor by a preliminary heating, and then maintained in incandescence by the heat of the current. Since the material is non-combustible, no vacuum is necessary, as a high temperature can be maintained the efficiency can be made higher than in the ordinary carbon-filament incandescent lamp. Until now no very definite information has been accessible concerning the efficiency of the Nernst lamp, and hence there has been a general interest evinced in Mr. Hulse's experiments.

These tests comprised the measurement on a direct-current circuit of life, candle-power, and watts under the following conditions: continuous run at normal pressure; continuous run at a pressure above normal; continuous run at a pressure below normal; continuous run with constant current; continuous run with constant watts expended in rod; test with varying volts (increasing till burner is destroyed); resistance test on the iron regulating resistance; heating effect of coil. In each case 100-watt 110-volt "burners" were employed. The candle-power of the lamps was ascertained by comparison with standard Ediswan incandescent lamps.

As a battery of accumulators was used to supply the current, a very much more steady pressure was maintained than would have been possible with the mains, the excess volts when charging the battery being cut down by a regulating resistance. The average variation in pressure for any long time was certainly not more than half a volt, and generally less, and it will be seen later that since that under perfectly steady conditions the lamp itself varies 2 to 3 per cent., sometimes more, a steadier run was hardly required. The life was in all cases, unless otherwise stated, perfectly continuous, only one break occurring in the circuit during the seven weeks during which the tests lasted.

As in the case of incandescent gas light mantles, a material falling-off in candle-power was shown almost immediately, this amounting to ten to twenty-five per cent. in the first half hour, according to the voltage. This was followed by a much slower drop for about 20 hours, followed by a slight recovery, after which the gradual fall continued until the effective life of the lamp was reached.

Taking the tests at the normal voltage, the operative life of the lamps appears to be about 400 hours, the candle-power being 67 c. p. at the start, with a consumption of 1.33 watts per candle-power, and falling to 28.5 c. p. at the expiration of 400 hours, when a consumption of 2.60 watts per c. p. was recorded. The average life of the lamps was about 500 hours, failure being due to the breaking of platinum contact at the positive end of the rod. Overrunning tests showed no advantages whatever, being not only detrimental to the life of the lamp, but also without the gain in efficiency which occurs with the ordinary incandescent lamp. The life is also much shortened by overrunning, so that there is no object whatever in attempting it.

Some very interesting tests were those in which a constant current wase maintained. Under ordinary conditions the current falls off to a large extent, and the burner is then no longer run at its best efficiency, the de-

crease in candle power being also objectionable and detrimental to the reputation of the lamp. But with constant current, the candle-power, after its first drop, which is characteristic of every case, remains constant until that point is reached where under normal conditions, the candle-power would have fallen off very rapidly, and here, instead of a drop, the candle-power increases for a short time until the lamp burns itself out.

The Nernst lamp will give on the average throughout a life of 400 hours at least .48 c. p. per watt expended, as against not more than .28 c. p. per watt in the case of good glow lamps. The cost of renewals would appear to be not more than three times as much for the Nernst as for the glow lamp, allowing for the shorter life of the former. In a 100-watt Nernst lamp the total energy used is over 35 units during economical life, and at 4d. a unit this costs 11s. 8d. or, say, not more than 15s., when all expenditure due to renewal of the burner is taken into account. Thus the Nernst lamp will furnish 1,000 c. p. hours at a cost of 11d., while 1s. 3d. is the approximate cost of the same amount of illumination from good glow lamps. In this comparative estimate the cost of renewals in each case has been included, the price per unit assumed to be 8 cents, while the glow lamp has been taken at an average of 3.6 watts per candle-power throughout a life of 700 hours.

The lamps tested by Mr. Hulse were of German make, and it is a matter for regret that he did not give full detailed drawings of their construction, in order that they might be compared with the lamps made under the Nernst patent by the Westinghouse company in the United States. Each maker appears to have made modifications in details, and from the account of the American Nernst lamp, as described by Mr. Wurts, in his paper before the Buffalo meeting of the American Institute of Electrical Engineers, it seems as if some of the causes for disintegration of the connections experienced by Mr. Hulse might be overcome. It would be most interesting to subject the lamps of various makers to simultaneous and identical tests, and in that way only can final information be obtained as to the best methods of working out the details.

The Combustion of Coal.

A RECENT issue of the *Electrical Times* contains a paper on the coal question in generating stations, which treats very clearly of the subject of the economical combustion of coal under steam boilers, and is so refreshingly free from any fog of technicalities as to attract interested attention.

After calling attention to the fact that the calorific values of the more customary coals do not vary over such a wide range as to demand the consideration which is sometimes given to that question, the matter of size is discussed. Here two distinct points are to be considered: the surface of coal exposed to combustion, and the space provided for the passage of air. With large coal there may be an excess of air opening between the pieces, and at the same time insufficient surface to the pieces in proportion to their volume to insure satisfactory combustion. As the size is reduced the relative surface for combustion is increased and the air space is diminished until combustion is retarded. There are thus three elements to be considered; draught, fuel-size, and thickness of fuel-bed. Hence for large coal the fire must be thick or too much air will come through unused, while for small coal the draught must be moderated or it will blow the thinner fire into holes, and air will pass through unused.

The real value of the large coal lies in the ease with which it can be burned, and this, rather than any unusually high calorific value, causes a high price for the coal. In other words, the price of coal is not fixed by its calorific capacity, but by its capacity for being burned. This is an interesting example of the manner in which commercial conditions may altogether confound scientific deductions; the most efficient fuel may not conduce to the highest economy of money. There are undoubtedly many coals of moderate price which are capable of being burned faster than is possible with natural draught, but, with mechanical draught and mechanical stoking, such coals would permit a high fuel efficiency as well as a substantial commercial advantage.

So far as efficient combustion is concerned, this is most difficult to secure in internally-fired boilers, owing to the close proximity of the relatively cold surfaces of the boiler. Externally-fired boilers, especially the wa-

ter-tube type, have possibilities, which, however, are but infrequently appreciated. In most instances the freshly generated gases from the burning fuel are flung up between the rows of cold tubes, and extinguished before they are half consumed.

The behaviour of a piece of bituminous coal, when heated on a hot plate, will give some instructive information as to what takes place in a furnace. Before the solid carbon becomes consumed, the volatile constituents must be distilled off. This takes place at a low temperature, and until this is completed the temperature does not rise, the analogy being similar to the evaporation of water, in which a constant temperature is maintained until evaporation is completed. This is due to the fact that the conversion of a portion of the solid fuel into gas absorbs heat, which becomes latent; an action which explains the remarkable dulling effect of a small quantity of fresh coal thrown upon a clear fire. Stoking by spreading the fresh coal upon the surface of the fire demands, therefore, a thick fire-bed, to resist this chilling action of the fresh fuel. The solid carbon can be burned all right, if the air supply be sufficient, but the distillation of the volatile matter is another thing.

It is in connection with this latter feature of combustion that the injurious effect of chilling boiler surfaces appears. Ample space must be allowed between the grate and the boiler, as well as a sufficient supply of air properly distributed. By raising the boiler somewhat, a grate of the step form can be used, the movement of the fuel being thus assisted by gravity, and a thick fire being more readily handled. An ordinary water-tube boiler cannot be properly kept smokeless without the use of a refractory lined furnace or combustion chamber in which the combustion may be effected before the gases meet the cooling tubes.

Anthracite needs a strong draught, the principal difficulty being to get enough air for complete combustion, and fires of even thickness are necessary. With bituminous fuels the difficulty is almost entirely that of temperature and suitable air admixture. It is most difficult to secure a high enough temperature to produce smokeless combustion unless, for some distance beyond the grate surface, there is but a small area of heat absorbing material. Hence the steady, though slow recognition of the principle of refractory linings to furnaces and combustion chambers, a principle long since proved correct in the laboratory, and already successfully carried out in practice.

"Between the most bituminous coal and the pure anthracites there exists every grade. Best Welsh coal, so-called smokeless, contains only about 4 per cent. of hydrogen, and burns with a short flame; but one cannot place a coal entirely by its percentage composition. The conditions which determine whether and how far a coal will be bituminous seem to be connected with the internal molecular arrangement of the coal and not with the simple empirical or percentage composition. Many of the long-flaming bituminous coals give off a flame more than 100 feet long, during all of which distance it is exposed to the cooling effect of a boiler. It seems probable that such coals, if burned in better and more favourable surroundings would burn with a shorter flame. To the difficulty in burning bituminous coal and conforming to the law as to smoke must be attributed the higher price paid for Welsh and other more dry coals."

The Standardisation of Pipe Flanges.

MUCH has been said on both sides as to the advantages and defects of standardisation, and on both sides there is much to be said. Excessive standardisation is undoubtedly a hindrance to improvement, acting as a bar to the use of important modifications, but there are certain branches of work in which standard sizes and proportions undoubtedly tend to advancement. Among such branches may be mentioned screw threads, both for bolts and for pipes, also standard reamers, twist drills, and similar details, the great advantage of uniformity in repair and contract work far outweighing any considerations which can be advanced as to the use of special sizes.

Closely allied to these subjects is the question of standard flanges for pipe joints, and hence the paper of Mr. Robert E. Atkinson, presented before the Institution of Mechanical Engineers is of interest. Without attempting to pass upon the merits or defects of any existing or proposed system, we may discuss the subject in a general manner, in connection both with the presentation of this paper, and with a considera-

tion of the work which has been done elsewhere.

The importance of the subject is well stated by Mr. Atkinson. Says he:

"The want of interchangeability is keenly realised in any class of work when breakdowns occur. Delays are frequently involved in obtaining renewals of valves or fittings, and in the case of an electrical-power installation this may involve serious loss. When public institutions, such as hospitals are concerned, the delay may prove more disastrous than the financial loss. Users will at once recognise that, without a common standard, their purchasing area is greatly restricted. Owing to the varied requirements as to the sizes of flanges, methods of drilling, etc., manufacturers find inconveniences and difficulty in speedy production, as it is impossible to commit themselves to the large expense necessary to produce high-class patterns, and up-to-date machinery, or to carry goods in stock, ready for delivery."

The subject is not a new one, having been considered by the American Society of Mechanical Engineers and the Master Steam Fitter's Association in the United States, and by the Verein deutscher Ingenieure in Germany, by both of which organisations definite standards have been prepared and recommended. In America, also, the manufacturers of valves and fittings have agreed upon a supplementary set of standards for use with heavy pressures, and in practice the result has been eminently satisfactory, since the user can purchase valves and fittings with every assurance that they will agree with those of other makers which are already in use.

In considering the question of a set of standards for British use Mr. Atkinson has not only examined the standards in use in America and Germany, but he has also gathered data and information from the practice of the principal manufacturers in Great Britain, most of whom agree with him as to the desirability of establishing uniformity.

In the paper, to which the reader is referred for details, the advantages and defects of the American and German systems are examined, and suggestions made as to the improvements which may be made. These may safely be left to the committee of the Institution to which the matter has been referred. For the present we may be permitted to comment on the discussion, which was instructive in that it showed most clearly two points of view, those of the maker and of the user.

So far as the matter was concerned, the question of proportion needs be considered in connection with the satisfactory performance in regular service and with the best economy in manufacture. From the user's standpoint, however, there enters the question of convenience at all times, of interchangeability, of emergency repairs, and of cost in erection, rather than of manufacture.

As Mr. Atkinson well said, a great proportion of the work done in connection with flanged joints is carried on at a distance from the works where they are produced; hence cheapness in first cost is altogether secondary to convenienc and saving of labour in fitting.

Standards must always be a matter of compromise, but when a decision must be made, it should be made in favour of the man who has to use the article rather than of him who makes it and can dismiss it from his thoughts. The great bone of contention lay in the matter of the number of the bolt holes. Theoretically the number and arrangement of bolts should be governed by the strength of the material and the stresses to which it must be subjected. Practically it is greatly influenced by the fact that it is most important in pipe fitting that every connection should be capable of being turned through an angle of 90 degrees, without altering the position of the bolt holes. This latter requirement led the American committee to make the number of bolt holes always a multiple of four.

The jump from four to eight holes seems too much to the theoretical designer, but the flange with six holes in it is an abomination to the steam fitter. So with the diameters of flanges, in which materials of various strengths may have to be connected together.

These are only a few of the matters which must be harmonised before working standards can be attained, but it is by a comparison of the requirements of both maker and user, that sound practical and theoretical results may finally be attained.

REVIEW OF THE CONTINENTAL PRESS

The Düsseldorf Exposition.

INTERNATIONAL expositions will always possess a great attraction for the general public, but it is a question whether the smaller and more specialised local displays do not offer much more for fruitful study by the engineer. This fact is especially emphasised by the exposition at Düsseldorf, which from its location as well as from its character and arrangement is undoubtedly a most interesting display of engineering progress.

At the enormous aggregation of exhibits seen at Paris it was in many respects difficult to arange matters so as to show the connection between the various departments of engineering work in a comprehensive manner, but in a smaller exhibition such an arangement is posible, and at Düsseldorf this important point appears to have been well kept in view. From an excellent account given in a recent issue of *Stahl und Eisen,* we abstract some general description of the exposition as it existed just previous to the opening and in our leading pages this will shortly be followed by a fully illustrated account of its progress, as seen by the special representative of THE ENGINEERING MAGAZINE.

Leaving the detailed description of the grounds and buildings for the forthcoming illustrated account, we may examine in general the arrangement of the engineering features of the exposition, especially with regard to the generation and application of power.

So far as the exposition in general is concerned, it may be mentioned that the covered buildings represent an area of 127,000 square metres, to which may be added 53,000 square metres of outdoor exhibits, or a total of about 180,000 square metres. This is about 20 per cent. more than there was at the Paris exposition of 1867, and is nearly 28 per cent. of that at the Paris exposition of 1900.

The generation of steam is effected by boilers of various types, arranged in two distinct plants, the main installation containing 16 boilers, with a total of 3,550 square metres heating surface, with coal firing, while the secondary plant contains 3 boilers each of 100 square metres surface, arranged to be fired with lignite. This second plant provides the steam for the steam hammers and for air compressors and rolling-mill engines. The main plant supplies steam for the various engines exhibited, amounting in all to about 12,000 h. p., most of which is used for the generation of electricity. Superheating is very generally applied, thus insuring dry steam, and a central condensing plant, capable of handling 30,000 to 35,000 kilogrammes of steam per hour, enables the engines to operate with an excellent vacuum. Although the location by the banks of the Rhine permits an ample supply of water, the condensing water is used repeatedly, in order to permit the exhibition of the operation of the cooling towers, these handling about 1,200 cubic metres of water per hour. Feed water purifiers, pumps, and varied auxiliary machinery completes this portion of the power plant.

The engines include vertical and horizontal compound types, from 3,000 h. p. down, besides a de Laval steam turbine of 100 h. p. and a number of gas engines. Especially interesting in this latter connection is the presence of one gas-driven blowing engine of 1,000 h. p., and two of 600 h. p., and also a complete gas power plant of 800 h. p. for operation of a rolling mill.

Although much electric driving is installed, an especial display is made of compressed air transmission, and numerous applications are installed, while hydraulic machinery, especially as used in iron and steel works, forms an essential feature.

We have then, at the Düsseldorf exposition an excellent opportunity of studying the latest developments in connection with the generating and applying of power. Large engines, supplied with superheated steam, and exhausting into a main central

condenser, supplied with cooling towers are directly connected with high-tension polyphase electric generators, for the distribution of energy in the most effective manner. Side by side with these are found internal combustion motors, fed with lean gas, and by-products, operating on the largest scale with high economy. The presence of compressed air and of hydraulic transmission, make comparisons practicable, while the small amount of belting and rope driving used serves only to emphasise the transformation which has taken place in the transmission and distribution of power.

The location of the exposition necessarily indicates that the principal exhibits of manufactured products fall within the departments of mining and metallurgy for which the district of Rhenish Westphalia is famous. The eminence of Düsseldorf as an art centre, however, gives the department of fine arts a prominence which might otherwise be lacking, and rounds out the whole in a thoroughly acceptable manner. It is too soon to predict the outcome of the exposition, but its influence upon the applications of science which constitute the field of engineering cannot fail to be both interesting and stimulating.

The Sterilisation of Water by Ozone.

We have referred more than once in these columns to the possibility of employing ozone in the sterilisation of water upon the large scale, with especial reference to the methods of MM. Marmier and Abraham, as installed at Lille, in France. We now have, in a recent issue of the *Gesundheits-Ingenieur*, an account of the apparatus of Siemens & Halske, with the results of an examination of its performance made by Dr. Erlwein, of Berlin.

All ozone generating apparatus is based upon the ozone tube of Dr. Werner Siemens, first made in 1857, in which electrical discharges between tinfoil-covered glass tubes, ozonised the air in the annular space between. The present practical devices are of two kinds, one employing flat plates, without water-cooling, and the other using tubular electrodes cooled by internal circulation of water.

The apparatus at Martinikenfeld, upon which the investigations of Dr. Erlwein were made, has a capacity of 10 cubic metres per hour. This apparatus, the details of which are given in the paper, consists essentially of suitable reservoirs, together with a preliminary rapid filter, for the removal of the major portion of the bacteria, of a tower for the treatment of the filtered water by ozone, and of the ozone generating plant. The rapid filters were of the Krohnke type, the water being forced through a body of sand by a head of about 2 metres. The ozone tower was 1 square metre in area and 5 metres high, and contained lumps of broken stone, the water being sprinkled from above and trickling down against the rising current of air charged with ozone. The ozone generator consisted of four pairs of plates, 1 metre square, each plate being of glass covered with a metallic coating, the dry air being delivered between the plates, and a pressure of 10,000 to 15,000 volts being maintained. About 1 horse power is required to maintain each pair of plates in action, and the delivery is about 25 to 30 grammes of ozone per h. p. hour.

The experiments were made upon a mixture of water from the Charlottenburg local supply and raw water from the Spree, and a number of examinations showed it to contain from 40,000 to 200,000 bacteria per cubic centimetre. After passage through the apparatus this water was in many cases absolutely sterilised, and in but a few instances there were found from 2 to 11 bacteria per cubic centimetre. The mean consumption was about 2.5 grammes of ozone per cubic metre of water, the air containing about 3 grammes of ozone per cubic metre.

An interesting feature of the process was the effect of the ozone in removing colour from water. The difficulty in decolourising waters containing iron, or colouring matter from peat beds, is well known, but these experiments showed that such colour is almost entirely removed by the action of the ozone. For such effects it is found desirable to follow the ozonising with a final sand filtration. A convenient arrangement for this purpose is shown, in which the ozonised air first bubbles up through the water, and is then delivered to the bottom of a tower containing broken stone. The water, after the preliminary contact with the ozone, is passed through a rapid sand filter, and then passed down through the tower, meeting the ozone once more, this procedure effectually

removing the colour as well as producing complete sterilisation, with a consumption of about 3 to 3.5 grammes of ozone per cubic metre of water.

The principal question, namely, that of cost, may be deduced from the above data, since it is mainly dependent upon the cost of power at the point of installation. Of the effectiveness of ozone in the sterilisation and decolorisation of water, there appears to be no doubt. Probably the practical application of the method will be found in combination with effective filtration plants for the removal of the greater portion of the bacteria, followed by treatment with ozone in times of epidemic or other occasions demanding additional precautions. The presence of colour may also determine the extent to which the ozone plant may need to be used, this forming a sort of auxiliary to the main filtration plant. The cost will in this way be kept within practical limits, while at the same time the administration will be at all times prepared to cope with any emergency which may arise.

Electric Tramways in Germany.

It is the custom of the *Elektrotechnische Zeitschrift* to gather and arrange the statistics of the electric tramways of Germany in a yearly exhibit, presenting the data in a very completely tabulated form, accompanying these facts with such comments as may enable the work of the year to be compared with the results of previous years. We now have the report for the year past, the data being brought down to October 1, 1901. This is a month later than has been the custom, the change being made in order to secure later data, and hence it must be remembered that the present figures are for 13 months. Included in the electrical data are the figures for the Marienfeld-Zossen high-speed military railway, although this is not for public transport, but solely for experimental investigations of the government.

The prevailing business depression in Germany has somewhat affected the construction of electric railways in Germany, at least to the extent of retarding new projects, and although good progress is shown, the remarkable development of the past few years has not been maintained.

As usual, the tabulated information includes the time of construction, character of system, as overhead, underground, accumulator, or special, also the length of track, number and character of vehicles, and data concerning the generating stations, whether the source of current is from a special station or from a general supply works.

It will be necessary to refer to the tabulated matter of the original article for detailed information concerning any particular railway, but a general summary may be given here.

The number of generating centres has increased from 99 on September 1, 1900, to 113 on October 1, 1901, a gain of 14 per cent., or about the same as in the previous year. The increase in track, however, has fallen off very much, the gain in road length having fallen from 40 per cent. in 1899-1900, to 8 per cent. in 1900-1901, and the gain in total track being but 6.9 per cent. as against nearly 50 per cent. in the previous year.

The existing roads, however, have been worked much more extensively, than in the previous year, so much so that the increase in electrical output of the stations has been as great as in 1899-1900, or more than 40 per cent., while there has been a gain of 21 per cent. in motor cars, and 25 per cent. in trailers during the past year.

There has thus been as great an increase in the generation of electricity for traction purposes as in the previous year, but it has been mainly expended in handling increased traffic over existing lines, and not in providing power for new lines. This is what might be expected, apart from any business depression; the most important cities having been provided with tramway systems, and the most urgent demands for interurban communication having been provided. Indeed it is a more healthy condition to find such a growth in the business of existing lines than to have it appear in the rush to develop new enterprises.

A noteworthy advance is found in the increased use of accumulator batteries for the purpose of equalizing the load upon generating stations, this branch showing a gain of 51 per cent. over the previous year. It is also interesting to note that the consumption of electrical energy per car has diminished and the consumption per kilometer has increased, thus showing an in-

creased efficiency as well as a gain in service.

At the present time there are in operation in Germany 3,099 kilometers (about 1,900 miles) of road, or 4,549 kilometers of single track, (about 2,800 miles), operating 7,290 motor cars and 4,967 trailers.

Germany thus remains far ahead of the other countries of Europe in the use of electric traction, although she is far behind the United States.

The principal object of interest in electric traction is undoubtedly the high-speed military road between Marienfeld and Zossen. Although various trials have been made, it yet remains to be demonstrated that higher speed can there be attained than has already been accomplished by steam locomotives. At the same time it is a matter for congratulation to find that such important experiments are undertaken by government, while at the same time it is curious to note that expenditures which would be most difficult to obtain for scientific experiments in the interests of peaceful industries are readily obtained for matters military.

Speaking Photography.

THE conversion of various forms of energy into articulate speech appears to be running through a course, which, if not altogether of commercial vale is none the less of great scientific interest. Thus the phonautograph of Léon Scott, which recorded the vibrations of a diaphragm under the influence of spoken words upon a smoked cylinder in translatable characters, was followed in 1877 by the phonograph of Edison, which even in its crude early form, was capable of "answering back" in more or less audible manner. Then came the graphophone of Berliner, the improved Edison phonograph, and the telegraphophone of Poulsen.

In the meantime the development of the telephone and the microphone, as remarkably sensitive receivers and converters of electrical variations into articulate sounds, came to aid in the problem.

In 1880 Professor Alexander Graham Bell, in the course of his investigations into the relations of the vibrations of light and electricity, devised the selenium cell, in which the impinging of a ray of light upon selenium modified its electrical conductivity, this enabling the action of the light to be converted into sound, and heard in a telephone receiver placed in the electric circuit.

More recently some very interesting observations have been made upon the action of vibrations upon electric arcs, and the researches of Professor Simon, of Erlangen, and of Mr. Duddell, in England, have shown that the electric arc may be used as a telephone transmitter. Thus, in the experiments of Professor Simon a transformer was placed in the circuit of an arc lamp, a battery and microphone being placed in the secondary circuit. Sounds delivered into the microphone transmitter were then clearly reproduced in the arc, which emitted musical notes, and responded visibly to the variations in the microphone. When the microphone is replaced by a telephone, the arc becomes a transmitter and the vibrations in the vicinity of the arc are converted into audible sounds in the telephone.

The result of such experiments naturally indicated the possibility of using the ray of light as a means of transmitting messages without the use of a wire, and in the radiophone of Professor Bell, shown at the Chicago exhibition of 1893 messages sent by a ray of light were received upon a selenium cell.

We now have a further application of this conversion of light into electricity and sound in the so-called photographophon, described in a paper presented by Herr Zacharias in a recent issue of *Glasers Annalen*. This apparatus, devised by Herr Ruhmer, consists of a receiver, in which the vibrations of an arc lamp are received and permanently recorded upon a rapidly moving photographic film, in a similar manner to that used in making moving pictures. When such a film is caused to move in front of a strong light, and the images of the marks on the moving surface are focussed upon a selenium cell, the variations in the light are converted into variations in electrical resistance, and thus into audible sounds in telephone receivers placed in the same electrical circuit as the selenium cell. Experiments with this interesting apparatus are still in progress, but thus far it has been found possible to photograph sounds and record them upon films for indefinite reproduction to unlimited audiences.

The utility of such a device is yet to be

demonstrated, and indeed the various forms of phonographs have so far proved themselves to be little more than toys. At the same time there are possibilities which may yet be developed which will render these interesting pieces of apparatus valuable. The moving picture has found its principal application thus far in amusing and entertaining various popular assemblies, although examples are not lacking of its use in scientific demonstration. The photography of the sounds accompanying an action upon the same film with the pictures, and their simultaneous reproduction would be an experiment at once interesting and valuable. Again it may be possible to convert light variations, themselves silent, into sounds which may lead to their interpretation in a manner hitherto impossible, and thus widen the scope of scientific research and discovery.

We have thus far been able to convert into sound the vibrations of mechanical, electrical, magnetic, luminous, and chemical forms of energy. It remains to reverse these phenomena, and transmit visible images by means of vibrations, a problem often announced as solved, but as yet undemonstrated, although there is every reason to believe it capable of solution.

The Modern Steam Locomotive.

In the course of an interesting paper upon the modern locomotive, presented before the Société d'Encouragement de l'Industrie Nationale, M. Edouard Sauvage brings out some points which may well be borne in mind when considering any sudden transformation in the character of motive power for main-line railways.

Thus it is estimated that at the close of the nineteenth century there were in operation upon the railways of the world, between 130,000 and 140,000 steam locomotives, not including machines used on tramways or other special service. That is to say, there is about one locomotive for every 10,000 inhabitants of the earth.

Assuming a very moderate estimate of value, M. Sauvage considers that these are worth 4 to 5 milliards of francs (£160,000,000 to £200,000,000—$800,000,000 to $1,000,000,000), while there are constantly employed in operating, tending, and repairing these locomotives about half a million men! Truly an important department of industry, and evidence of the impress which the work of the engineer has made upon the civilisation and industry of the world!

Without attempting to discuss the details of all the varied types of locomotives, M. Sauvage gives some interesting points concerning the development of the locomotive in various parts of the world. Concerning the normal gauge of 1,435 millimetres (4 ft. 8½ in.), this has been considered too narrow, by many, and there is no doubt that wider gauges have their advantages. At the same time M. Sauvage points out that, even with the present gauge, the load upon the rails has increased to such an extent as to demand the greatest stiffness and weight, and this would have been even a more severe requirement had there been wider locomotives and cars to be carried. Thus in Europe, prior to 1875, the usual weight of an express passenger train, not including the locomotive and tender, did not exceed 100 metric tons, and it is but a few years since a train of 200 tons was considered very heavy. To-day we are approaching trains of 300 tons, demanding locomotives capable of hauling them at express speed.

For freight trains, and especially for mineral trains, it is the question of the cost of transport which is the determining element, but for passenger service other conditions predominate, such as speed, convenience and luxury of vehicles, frequency of trains, etc., and these must be provided independently of cost of construction or operation.

The handling of freight, as M. Sauvage well says, not always best done by heavy trains at slow speeds, although this may appear to be the most economical of fuel, and hence of total cost. There are other things besides fuel which enter into the cost of the ton-kilometre. In England freight trains of moderate weight are hauled at fair speeds, usually by engines with three coupled axles. On the Continent the slow, heavy trains prevail, while in the United States very heavy trains, drawn by colossal locomotives with four coupled axles, with weights of 18 to 22 tons per axle, are found.

As already indicated, the elements of total cost are numerous and complicated, and it is a mistake to consider the effici-

ency of a locomotive as dependent directly upon the fuel consumption. It is comparatively easy to charge each locomotive with the fuel and lubricant consumed and with the repairs which it requires, as well as the wages of its attendants. The proportion of general expense and the charge for its own depreciation may be closely approximated so that in general the debit side of the account may be considered as fairly attainable. On the other hand, it is most difficult to measure the service which is rendered by a locomotive in any manner which can be made comparable with other engines. Sometimes it is taken as proportional to the mileage, but this is a very indefinite element when the weight and speed are not included. The train-mile is also indeterminate, since the weights vary, and the speed and the profile of the line may still exert preponderating influences. The service which a locomotive may render also depends in a very great degree upon the usage which it receives. If powerful engines are used to haul moderate trains and given close attention and care, the fuel-consumption and repair-expenses per kilometre may be kept low. If, on the contrary, the engines are given the heaviest trains which they are capable of hauling at the required speed, the boilers are forced and the steam is not used economically, and the fuel consumption is necessarily high. At the same time the expense of attendance is much better utilised, and especially the capital charges form a far smaller element in the cost per ton-kilometre. It must be remembered that the whole question of freight transport is not one of the locomotives alone, to be considered as regards their economical performance by themselves; they should always be considered in connection with all the expenses of the entire railway management and operation.

M. Sauvage proceeds to examine modern locomotive construction in detail, considering the machine as composed of three distinct elements, the boiler, or steam generator; the engine, in which the steam is used; and the vehicle, by which both are carried. It is impossible here to follow him in the study which he makes of the details of each of these essential portions, the reader must be referred to the original paper, and to the paper of Mr. Charles R. King, commenced elsewhere in this issue. It is sufficient to recall the fact that the subject is treated in the broadest manner, by an engineer, who while French by nationality and practice, is cosmopolitan both in ideas and information, one whose opinions are far above local or national prejudice, and are based upon wide knowledge used with consummate ability.

Industrial Applications of Carbonic Acid.

THE practicability of producing liquefied gases in commercial quantities has led to the suggestion of various useful applications in the arts, and in certain directions such applications have already become of material importance. Carbonic acid was one of the earliest of the gases to be reduced to a liquid state, and is still one of the cheapest and hence it has advanced furthest in its industrial applications. For this reason the exhaustive paper of M. E. Mathias, in recent issues of the *Revue Générale des Sciences*, upon the preparation and uses of liquid carbonic acid demands notice, and the record which is given of existing practice may lead to further applications.

Taking up first the production of liquid carbonic acid, M. Mathias divides the methods into two classes: those which produce a gas sufficiently pure to be reduced to the liquid state with but a slight preliminary purification, and those which produce a gaseous mixture containing from 15 to 35 per cent. of carbonic acid, the balance consisting of air or other inert gases, which are not absorbed by an alkaline carbonate. In the first class are grouped the processes using the gas from natural sources, such as are found in volcanic districts, also the gas given off during the fermentation of grain in brewing, and the gas produced by the action of acids upon natural carbonates.

Passing over the first source as of limited use, we consider the utilisation of the gas produced in the operations of brewing. This source of gas is due to the fact that in the transformation of glucose into alcohol, there is liberated, along with small quantities of glycerine and of succinic acid, a quantity f carbonic acid about equal in weight to that of the alcohol formed. This gas is very pure, but it is given off very slowly, and its collection is attended with various difficulties, so that up to the pres-

ent time most of it has been permitted to escape unutilised.

The production of carbonic acid by the action of dilute sulphuric acid upon limestone or marble dust was at one time the principle method employed, but it has now gone almost entirely out of use. The gas contained entrained sulphuric acid, as well as salts of lead, and these are by no means removed by the purification methods ordinarily employed, and indeed the use of gas made by this process is prohibited in several countries.

The present method, is usually that of the second class, in which a gaseous mixture, rich in carbonic acid, is passed through a solution of an alkaline carbonate, from which the absorbed gas is afterwards separated by heat and collected in a receiver for liquefaction.

The gas for use by this method may be produced in a great variety of ways, the great advantage being that the process may be used in connection with some other branch of manufacture, from which the gases are a by-product of trifling cost. Thus furnace gases, containing a large proportion of carbonic oxide, may be burned completely to carbonic acid, and the resulting mixture passed through a scrubber and then absorbed by carbonate of sodium or potassium. Gas from lime kilns or from coke ovens may be used, or in fact any source of carbonic acid as a by-product which does not render it liable to contain gases which are absorbed by the alkaline carbonate. The absorption of the gas is effected in some apparatus similar to the well-known Glover tower, the principle object being to insure as complete a contact as possible between the liquid and the gases. By then exposing the solution of carbonic acid to heat, usually by means of steam coils, the gas is given off again. It is then practically pure, requiring only filtration through charcoal, and drying with sulphuric acid, or with chloride of calcium, to be ready for compression.

The liquefaction is usually effected in a two-stage compressor, the gas being cooled between the stages, the pressure depending upon the temperature, and ranging from 70 to 80 kilogrammes per square centimetre (995 to 1,138 pounds per square inch.) The liquid gas is pure, with the exception of a small quantity of air, which latter may be removed, when an absolutely pure gas is required, by fractional distillation.

M. Mathias describes the construction and use of the cylinders in which the liquid gas is collected and transported, and then proceeds to discuss some of the commercial applications of the product. Naturally one of the first applications proposed was that of artificial refrigeration. By the use of the liquid gas as a medium in refrigerating machines in a manner similar to ammonia, practically the same efficiency may be obtained with apparatus of much smaller dimensions.

The more general use of the liquid gas, however, is as a portable material for the production of cold. In this way it is employed in hotels, restaurants, and similar service. It is also used in the same connection for the carbonating of waters, for the enlivening of malt liquors, and in the form of the well-known "sparklets" these applications have become familiar in the household.

Attempts to use the liquefied gas as a source of motive power must necessarily be very limited. In all stationary situations the power will always be more economically produced by direct means similar to those employed for compressing the gas. When, however, economy is not the question, as in aeronautics, or in submarine torpedo work, it may be possible to use some such form of stored energy, but up to the present time, no really satisfactory carbonic acid motor has been made, although numerous attempts have been made by eminent engineers.

Among uses as yet of minor importance, but which may develop into commercial value, may be mentioned the application in tanneries, for the removal of the lime used to take the hair off the skins; in processes of sterilisation; for the extinguishing of fires; and especially of its employment, as by Krupp, in steel-working, both for the contraction of hoops on guns, by cooling, and for the compression of steel ingots, by the enormous pressure produced at high temperatures.

In addition to the above applications, liquefied carbonic acid is of use in the laboratory for various experimental purposes, as well as in practical chemical technology, materially increasing the range of temperature available at the lower end of the scale.

The Evaporation of Water.

AMONG various industrial operations there is probably none more common than that of the conversion of energy by means of the evaporation of water by the application of heat to the exterior of a containing vessel.

Some portions of this subject have been very fully investigated, especially those relating to the steaming capacity of boilers in power plants, but these have mainly been determined on the basis of evaporation per unit of heating surface and of grate surface, as well as per unit of fuel consumed, and observations upon temperatures have necessarily been limited. When lower temperatures are employed, however, as in the case of evaporating pans, and steam coils such as are used in sugar refineries, and in breweries, it becomes possible to make more reliable experiments and to determine data and co-efficients for scientific work. At the same time there is no very reliable information at the quantitative relations between heat applied and water evaporated, although the theoretical questions are very definitely established. Thus the experiments of Mollier showed the coefficient of heat transmission, or the quantity of heat transmitted through 1 square metre in one hour for a difference of 1 degree centigrade, for very thin copper, varied between 2,270 and 6,900 calories. Since the influence of the thin metal might be neglected, these great variations can only be attributed to errors of experiment, and Mollier suggested that they might be due to entrained air.

Taking average conditions into account, he states that a fair value may be considered to be about 3,500 calories.

The whole question has been made the subject of a very thorough series of experiments by Dr. H. Claassen, and from a paper which he has recently contributed to the *Zeitschrift des Vereines deutscher Ingenieure*, some interesting conclusions may be given.

So far as the experimental results are concerned, these are fully tabulated in the paper, to which reference must be made; but an examination of these results shows that the coefficient of transmission depends upon three elements: the temperature of the heating medium, usually steam; the temperature of the evaporated liquid; and the rate of variation in temperature.

Thus for a heating temperature of 100° C. and an evaporative temperature in vacuum pan, of 60.2° C, the transmission coffiecient was 2,816 calories, while with the same heating temperature and with an evaporating temperature of 71° C., the coefficient fell to 2,126 calories. Again when evaporating against atmospheric pressure, or at a temperature of 100° C., with heating temperature of 110.5° C., the coefficient was 1.823 calories, while when the heating temperature was raised to 124.8° C., the coefficient became 2,947 calories, showing the increase with the increase in difference of temperature.

The experiments also included researches upon the influence of the concentration of the solution to be evaporated, in the case of apparatus for the evaporation of saline or saccharine solutions, as well as the influence of the depth of the liquid in the pan, and consequent head of water against which the evaporation was effected. All these results are fully tabulated, thus furnishing valuable data for reference.

In general the conclusions drawn from the experiments were as follows:

The coefficient of heat transmission increases with an increase in the difference of temperature, but within the limits of the investigations the law of this increase could not be determined.

The coefficient of transmission also increases when both the temperatures of heating and of evaporation are increased. The coefficient is diminished when the head of water on the liquid is increased, this naturally being due to the increased pressure.

In the evaporation of water from solutions, the coefficient is much affected by the character of the solution and by the degree of concentration. Under similar conditions saline solutions show slightly higher coefficients than pure water, while for saccharine solutions the coefficient diminishes with the concentration.

The arrangement and character of the heating surface naturally affects the evaporation, and the use of superheated steam for evaporating is followed by a very marked increase in the value of the coefficient of transmission.

REVIEW OF THE AMERICAN PRESS

The Maximum Loading of Trains.

IN the attempts to secure the greatest commercial economy of the transport of merchandise there has been a continual increase in the weight of freight trains, and the advantages of maximum loading have been advocated as conducting the greatest economy. This important question in railroading was discussed at length in a paper recently presented before the New York Railroad Club by Mr. E. E. Russell Tratman, and published in *Engineering News*.

The real question at issue appears to be the determination of what is really maximum train loading, and whether, in the attempt to secure maximum loading it does not sometimes become excessive loading. On this point Mr. Tratman says:

"In certain cases, no doubt, the maximum loading has been carried to an extreme But whatever may be the facts in individual cases, there can, I think, be no doubt that the heavy engine, heavy car load and heavy train load have been proved satisfactory and have come to stay. It is futile for the equipment man to complain that the cars are being damaged by the new conditions, or for the maintenance-of-way man to complain about the effects upon the track, with any idea that the conditions will be modified to suit the cars or track. On the contrary, the cars and tracks must be made to fit the traffic conditions, and rightly so, since it is the traffic which makes the business and earns the revenue. There is not the slightest prospect of any backward step in the present tendency to consolidate freight traffic into heavy trains hauled by heavy engines, and it is the proper way and work of the various departments of the service to facilitate operation of traffic under these conditions to the best of their ability."

In examining this question Mr. Tratman has made extensive inquiries concerning the wear and general injury or disturbance to track on the divisions where the heaviest engines are employed, in order to be able to make a balance account between the advantages and disadvantages of the system. The details of the responses to these inquiries are given in the paper, to which the reader is referred, but the general conclusions may be given here.

The reports show that the heavy traffic has involved much wear and tear upon the roads, and that the work and expense of track maintenance have increased with the use of heavy engines and trains.

Additional wear and failure has also been shown to occur upon the cars and rolling stock in general, but at the same time the losses from all these additional expenses do not offset the gain due to the higher efficiency of the system as a whole and to the greater proportion of productive to general expense. Taking all these points into account, as deduced from authoritative responses from many of the leading railways in the United States. Mr. Tratman draws the following conclusions:

1. The heavy engines, cars and trains for freight service have come to stay, for the reason that the "maximum train" method of handling the traffic has shown an ultimate economy in spite of the large sums expended in improving the road and the rolling equipment.

2. There is undoubtedly an increased wear of the track and cost of maintenance of way due to the heavy equipment and trains and it would be wise economy in very many cases to make liberal expenditures in materially increasing the strength of the track. The engineer has been able to show conclusively the ultimate economy to be obtained by large expenditures in general improvements and it is now time for the e gineer of maintenance of way to show a similar economy, to be obtained by expenditures upon the track itself. If he fails to impress the management with a realization of these economies, the only thing to be done is to make the best of what he has for there is no chance of driving away the heavy en-

gines, cutting down the car loads, or reducing the train loads to conform to the economical capacity of the existing track. Besides the track proper, improvements in passing tracks, double tracking, yard and terminal facilities, etc., offer further opportunities for effecting economy in operation.

3. While the present large engines and cars are generally satisfactory, many improvements remain to be made, especially in reducing the dead weight and strengthening the weak parts which develop under the severe conditions of service. Improvements in draft rigging, in brake equipment and in the proper maintenance of coupler and brake equipment are specially to be noted. It seems unlikely that the capacity of cars will be increased. Such a step is neither necessary nor desirable, for, with the exception of certain class of freight (and these often hauled in one direction only), the large cars are very frequently run with loads far beneath their capacity.

4. It would seem that we had about reached the limit of economical weight of the locomotives. Actual weights may still be exceeded in certain cases, but engines of 90 to 125 tons may fairly be considered to represent the limit in mere power and weight. The future progress will be rather in increasing the number of such engines, in improving their construction to obtain further economy in service and in improving the methods designed to work them to their full capacity.

5. The tonnage rating system for making up trains has by no means reached its full development, either in the facility of its application under varying conditions, or in securing the desired end of uniformly giving the engines a full load. In fact, much greater development may be expected in these directions than in the direction of building heavier locomotives.

6. Improvements are much needed in the work of getting the traffic over the road with as little delay as possible. These may be effected partly by increased track and terminal facilities, additional tracks, modern water and coal stations, the block system, etc., but more especially by greater promptness in handling cars and trains at division and terminal points. Closely related to this matter are the problems of restricting the use of cars for storage and the improper use of foreign cars. An auxiliary fast service of smaller and lighter cars for the economical and prompt handling of small shipments in local freight traffic may come at some future time as an offset to the comparatively slow and enormously heavy trains of large capacity cars.

This discussion of the subject only emphasizes the position taken elsewhere in this issue in discussing the performance of Belgian and American locomotives in Egypt, namely, that no detail in railway management should be considered by itself, but that it is the profitable and advantageous working of the whole which must always be considered.

The Service of the Automobile.

In an interesting paper recently presented before the Engineer's Society of Western Pennsylvania, and published in the *Proceedings* of the society, Mr. Hiram Percy Maxim discusses automobiles from a very practical standpoint.

Leaving on one side the present popularity of automobiles as pleasure vehicles, Mr. Maxim proceeds to discuss the question from the position of the engineer, and to show its relation to existing conditions of transportation.

"Urban or city transportation, or at least that part of it which is to-day having trouble with its motive power is divided into four classes:

1st. The transportation, in a private vehicle, over irregular routes, of usually one but possibly two passengers engaged in such service as the daily visiting of physicians, contractors, collectors, inspectors, and similar business men.

2d. The transportation of one or more passengers over irregular routes in a hired vehicle driven by a hired driver, or, as is better known, cab service.

3d. The transportation of several passengers by regular omnibus lines on city streets which are prohibited to street cars.

4th. The collection transportation and distribution of miscellaneous, city and suburban merchandise.

In every one of these services the horse has gradually become unsatisfactory as a motive power. The reason for his inability to prove satisfactory now, when he has been

satisfactory for centuries past, is of course due to the changes that have been made in motive power in all other branches of transportation. If it were not that system railroad and the electric street car had set standards which other forms of transportation must meet, there is no doubt that the horse would have continued to give satisfactory service in the work we are considering.

In order to provide data suitable for an engineering consideration of the subject, Mr. Maxim made mileage tests, showing the proportion of the time which a vehicle rendered available service. He also made investigations into the energy expenditure per ton-mile in various kinds of service, with the result of showing, from plotted curves, that the automobile, even as it exists to-day is better able to do the useful, commercial work of transport, than is the horse.

These investigations, as discussed in the paper, extended over all four of the classes enumerated, and in all of them the superiority of the machine over the animal is shown, although in varying degrees. The most favorable showing appears to be in the transport of merchandise, such as local express service. This service is undoubtedly destined to grow with the rapid extension of local delivery into suburban districts, where the horse is most deficient because of the necessity for higher speeds over continually increasing distances.

Mr. Maxim is of opinion that electric motive power is the best for all such city service, and undoubtedly it is in the city, if anywhere, that electricity can do its best work. At the same time the developments in internal-combustion motors for automobile service have made them the favored power for long-distance service, and it is by no means certain that they will not prove the best for business purposes.

Comparing the two sources of power, Mr. Maxim says:

"I think electricity as a motive power will be used first for express service because we can get the maximum reliability from it. In making the substitution of a mechanical motive power for the horse in express service to-day we have to get something that will work pretty nearly right the first time. As far as reliability goes we might say that electricity is almost foolproof. We are dealing with a revolution here. We have to throw down a lot of strong ideas and prejudices, and it is my conviction that electricity will take the field in express service first because we can make the electric automobile so that it is almost independent of any skill on the part of the driver. The driver need only steer and apply the power and take it off. There is no other form of motive power available yet in which such simple operation is possible. There are two other motive powers in use to-day. The gasoline engine and the steam engine. We probably stand a better chance of getting an absolutely automatic motor with gasoline than we do with steam. We can now produce a horse power hour cheaper with it than with any other motive power suitable for a vehicle. We can probably get the H. P. hour for one-half what we can get it with a steam plant on the same vehicle. It seems very doubtful whether we shall ever get a steam plant entirely automatic—one which it will be safe to make automatic. Therefore, just as soon as we can produce a gasoline motive power equipment which requires no more skill to drive than the electric machine does to-day, where engine power counts for anything, the gasoline machine may be better than the electric. I do not believe that steam has any chance whatever. That is why I say it is probable the electric machine will not always have the lead. In express service, where they cannot afford to have anything unreliable, the gasoline may eventually give the electric automobile a hard rub. But I have been unable to see any chance in that service for steam."

Leaving the question of details of construction out of the question, and considering the matter solely from the point of the demands of existing transport conditions, it cannot be denied that relief may be had from the mechanically propelled vehicle, operating independently of any fixed tracks.

"Our cities nave already spread to areas which make the irregular transportation of passengers and merchandise over them most difficult, and the continued development of the prime cause of it all—the electric street car—is daily increasing the difficulties. The automobile comes as a successor to a part of the work of the horse, just as the electric street car came as a suc-

cessor to part of his work. From the very nature of our civilization it becomes an absolute necessity. The mechanically propelled street vehicle is as inevitable as was the mechanically propelled boat, railroad train and street car, and we might as well include such institutions among our fads as to include the automobile. When it comes to their manufacture, where we will build one for pleasure, sport, or fad, we will build one hundred for serious work."

Compensation of Skilled Labor.

THERE has been much written of late about the methods of compensating labor, but most of it has related to the general details of different so-called systems, including such forms of incentive as have appeared available to obtain the best results. It is therefore refreshing to have the matter discussed on its broad and fundamental principles by such a man as the veteran, Mr. John Richards, whose experience as an engineer, manufacturer, and employer of labor on both sides of the Atlantic renders him especially qualified to speak on this vital matter.

In a paper presented before the Technical Society of the Pacific coast, and published in the *Journal of the Association of Engineering Societies,* Mr. Richards treats the subject in a manner so logical, and so well adapted to existing and future conditions, that his views demand extended notice.

In the first place he calls attention to the necessity for a logical definition of the word "wages."

"Does it mean the money compensation for workmen's time, or does it mean compensation for work accomplished? These things are essentially different and require different terms to define them. The first is a "rate" of wages, while the second is the "amount" of wages. I beg that you will keep these terms in mind, because out of them and the relation between them must arise much that will be said of compensation.

"The 'amount' of wages, or compensation for work accomplished, is the labor cost that enters into commodities, and constitutes the real economic problem, the one that directly affects our industries and determines their success.

"The 'rate' of wages, or compensation for workmen's time, is a social rather than an economic problem, dealing with the intellect and skill of workmen, their ingenuity and power of producing; consequently it affects directly the workmen themselves.

"The amount of wages is very uniform the world over when measured by product—indeed, must be so, as will appear—but the rate varies with the productive power of workmen.

"It does not much matter to an employer whether it requires one, two or three workmen to produce a given result in a given time. He can as well pay the amount of wages to three men as to one man or two men. The amount of the wages, measured by production, is the matter he is directly interested in; but to the workmen the rate is a serious matter, directly affecting their social and other conditions, because it is a measure of their personal compensation."

Having arrived at this distinction concerning the possible meanings of the term "wages," Mr. Richards proceeds to show the postulates upon which he bases his discussion.

First. The costs of manufactured articles of every kind are made up of four elements or components; namely,—material, wages, expense and profit.

Second. All staple articles of manufacture, such as enter into the world's trade, must have a nearly uniform or international value.

Third. The amount of wages, entering into the cost of manufactured commodities, is also nearly uniform, and must be so, irrespective of the *rate* of wages paid for their production.

Fourth. The rate of wages depends upon what workmen produce, or upon efficiency of their labor and to some extent on artificial values.

Fifth. Fluctuations in the rate of wages are commonly a result of demand and supply.

Sixth. The amount of wages that can be paid to produce a commodity is not an accident, but is the result of fixed commercial laws of general operation, and upon the relation to other components.

This idea of the general or world's value of products is the natural outgrowth of the general exploitation of the surface

of the earth and the practicability of easy and rapid communication between various nations. As a result, demand and supply, due originally to the difficulties in distributing the products of labor to various parts of the world, no longer regulate the wages element of value, and the values of articles are measured by the cost of their production, irrespective of the location where they are made.

Considering now the question of employment, Mr. Richards divides the methods into four classes:

First. In the scale of personal service is slavery, where workmen are not responsible.

Second. Time service, in which workmen are partially responsible.

Third. Piece work, where a workman is responsible for his own work alone.

Fourth. Contract work, where a whole working force is collectively responsible.

"Now these four methods or systems of service have the several degrees of responsibility named; that is, from all to nothing. Responsibility is the key to efficient skilled service. It forms the distinction between free and slave labor and the incentive of effort."

Here at once is seen the fundamental principle of the compensation of labor. Men are paid, not only for the actual articles which they produce, but also for the degree of responsibility which they bear. Just so far as the time system resembles slavery, so far it is degrading, tending as it does, to relieve the men from responsibility. Piece work is a step in advance, but only a half-way house; the contract is a still further advance, and in the present constitution of society, it places the men upon precisely the same basis as the employers; they are in business for themselves as much as the firm is for itself.

In the modern developments of industry there is no possibility for the position of labor to stand still. Manual work is being replaced by machinery wherever it is possible for it to be done, and the result is an inevitable sorting out of the men according to their individuality.

It has often been said that great industrial combinations have made it impossible for a man successfully to conduct a manufacturing business on his own account. Under the old conception of things this is probably true, but the old conception of things must be abandoned because it *is* the old conception. As a matter of fact every man who is really competent may go into business for himself more readily than ever before, he can do so without any stock in trade except his head and his hands, and he will find that the work of his head is far more valuable as capital than the efforts of his hands. The great corporations are to him what the great purchasing public was to his predecessor, an unlimited array of customers. If he will use his head he can sell to all the world his judgment, his responsibility, his brains, and the volume of his business will depend upon his product. If he insists upon selling the product of his hands only, he will always find himself a petty shopkeeper.

Herein the labor organizations make their great mistake, lagging, as they must necessarily do, behind the pace of the individuals. In demanding that their members do time work only, in limited working hours, with limited output, and avoidance of responsibility, they really demand that all distinctions of skill be destroyed, and, such a system, if possible, would reduce all to a homogeneous class like common, unskilled laborers.

The Speed Regulation of Prime Movers.

AMONG the valuable papers presented at the New York meeting of the American Institute of Electrical Engineers were two upon the subject of the regulation of prime movers for operating alternators in parallel, one of these being by Mr. C. P. Steinmetz and the other by Mr. W. L. R. Emmet. These are now published in the *Transactions* of the Institute, together with the valuable discussion, so that the subject may now be reviewed as a whole.

Mr. Emmet discussed the behavior of alternators operated in parallel, and described his investigations to discover the cause of the oscillations which made their appearance when two generators were started in parallel, and after vainly searching for the source of trouble in the electrical portion of the plant, he finally determined it to be in the engines. Here it soon appeared that the trouble lay in the periodic action of the governor, which,

while performing its intended function of maintaining a closely uniform mean rotative speed, created angular oscillations in its efforts to respond to the varying impulses upon the piston.

Such oscillations naturally result from the sensitiveness of the governor for the work for which it was originally designed, that is, for the maintenance of a nearly uniform rotative speed, and the remedy is naturally found in the use of a damping device, usually some form of dash pot. This, while preventing excessive oscillations, also reduces the sensitiveness to load variations, but in most instances this is not felt to an objectionable extent. When a strong damping effect is desired, the ingenious time-delay dash pot of Mr. Harte Cooke may be used, this acting to interpose a heavy resistance to the change of governor position for a short period, but permitting it to respond to the least change of speed if persistent beyond the period of oscillation.

An interesting point in this conection is the fact that an increase in the weight of the fly wheel is not necessary, nor is it advisable. Mr. Emmet says:

"It is popularly supposed that it is necessary to use very heavy fly wheels in order that alterators may be successfully operated in parallel; it being the custom of some engineers to consider a guarantee of small angular variation as the equivalent to a guarantee for parallel operation. Experience indicates that generators with light fly wheels are most easy to operate in parallel. The frequency of natural oscillations in such machines is high, and the conditions of engine operation are generally unfavorable to their development. Large fly wheels are desirable on direct-coupled alternators, because a steady frequency is a valuable feature in any system. The requirements of parallel operation, however, are rather unfavorable than otherwise to the use of heavy fly wheels."

This apparently anomalous effect is due to the fact that the lighter the fly wheel the less the intensity of the pendulum effect of the oscillations, and the less the resistance necessary to apply to the governor in the shape of dash-pot resistance.

The discussion is especially interesting in that it shows the inter-relation between the various departments of enginering. Until the question of running alternators in parallel came up, a few years ago, there was probably no one feature in steam engine design which was supposed to be more thoroughly worked out than that of speed regulation and control. The electrical engineer comes forward with new requirements, and immediately the subject is reopened and the new conditions met in a scientific and commercial manner. The whole question shows the transformation in methods from the time when invention was regarded as a sort of lucky accident, to the present practice, in which operative phenomena are examined in a scientific manner, and the requirements met in the regular course of design and construction.

The Purification of Sewage.

THE question of the purification of sewage is one which is gradually being taken up of necessity by nearly every municipality since either local conditions demand its consideration, or else the pressure of external influences come into action.

A very interesting paper, dealing broadly with the whole subject was recently presented before the Western Society of Engineers by Mr. John W. Alvord, and published in the *Journal* of the society, from which we make some abstracts.

The subject of purification of sewage has interested not only the sanitary engineer, but also the medical profession, the chemist, the bacteriologist and the municipal expert. The result of this has been that the language of this specialty has become replete with technical terms, drawn from these various professions, which cause it to be sometimes rather unintelligible. Moreover, as is the case with every art which is in a rapid state of advancement, new theories are constantly being propounded, so that the observer is often perplexed in his attempt to decide just how much of the art is safely or surely determined, and just how much is still in a theoretical stage.

Mr. Alvord calls attention to the fact that sewage purification plants are not as popular with municipalities as water works, for instance, and hence the operations are often carried on only to such an extent as will satisfy the pressure of necessity. This was especially the case in former years, when the

expense was greater than at present, but even with the improved biological methods the necessity for skilled supervision remains.

"The purification of sewage as now practiced most successfully requires that the process be divided into two stages:

"In the first stage there is the necessity of eliminating all of the greater portion of the particles of suspended organic matter contained in the liquid. This is accomplished more or less successfully by screening, sedimentation, chemical purification, roughing filters, bacteria beds and the septic tank. At the present time the septic tank is generally considered to be the most economical and efficient means of accomplishing the first stage of purification.

"The second stage of purification consists of removing the more finely suspended residue and the impurities in solution. There are many ways of accomplishing this, known by different names, but the general principle underlying them all is that the liquid to be purified must be brought into contact by wide diffusion at innumerable points with certain forms of nitrifying bacteria in the presence of a sufficient supply of oxygen and retained under such conditions a proper length of time for complete chemical change to be accomplished; this properly done, the liquid is found to be purified. Most of the methods by which this principle is practically applied involve intermittency of application of the liquid to the filter and its alternating aeration. This second stage involves processes commonly known as broad irrigation, intermittent filtration, bacterial contact beds, filters with forced aeration and continuous filters."

Discussing the successive stages of purification, Mr. Alvord calls attention to the importance of giving proper study to the design and operation of the septic tank. It is in the tank that the first and most important stage of the purification is accomplished, and that, by a species of bacterial fermentation, the solid matter is broken down and either discharged as inoffensive gas, or passed into solution.

The septic tank has passed through the period of doubt and distrust and is now being carried along on the popular wave of enthusiasm. It has come to pass that almost any one thinks he can design such tanks, although he may only have read of them. Accepting the English dictum that the sewage should rest in the tank from 12 to 24 hours, many tanks in this country have been designed on this basis, ignoring the fact that English domestic sewage will often average about four times the strength of American sewage, and that the English climate is quite different from the climate in this country. Mr. Alvord has found that septic tanks are not to be designed on haphazard principles, and has developed a theory from four years' practical experience in the operation of such tanks, that the particles of every sewage require a rest or fermentation period within the tank the length of time of which must be adapted to their temperature, their concentration, their character and the volume of flow. It has been clearly shown that if this fermentation period is unduly prolonged poisons are created which are detrimental to the life and activity of the anerobic bacteria. Such impairment of their vitality reduces their activity and fills the tank with undecomposed suspended matter, which must be necessarily cleaned out quite often and produces an effluent which it is difficult to oxidize. On the other hand too short a fermentation period does not effect that degree of purification of the suspended matter which is possible and allows considerable suspended matter to be carried over onto the filters to their detriment, and also causes the tank to fill with sludge.

The second stage consists of the oxidizing of the organic matter in solution, this naturally involving the effective contact of the liquid with air. Various methods have been adopted to accomplish this result, including broad irrigation and intermittent filtration. The objections to the former have been both the cost of land near large cities, and also the offensive accumulations which followed the method when raw sewage was turned directly upon the ground. Contact beds, however, have been demonstrated to be altogether capable of dealing with the problem, and of such beds Mr. Alvord gives some interesting information.

Comparing a contact bed to a huge lung, in which the filling and emptying of the liquid corresponds to the inhaling and exhaling of the breath, he shows the importance of providing proper, and if possible

automatic control of the intermittent action. The early filter beds in England required raking and cleaning, but these were operated with raw sewage, containing solid matter. With the advent of the septic tank, and the consequent preparation of the sewage in liquid form, automatic devices became possible, with a result of increasing the efficiency of the process while at the same time reducing its cost.

It is customary to operate contact beds with two hours resting full, thirty minutes to empty, three hours resting empty to aerate, and thirty minutes or so to fill, thus dividing the day into six-hour cycles and providing for four fillings per day. With strong sewage, eight-hour cycles and three fillings and emptyings per day are sometimes best. All this work may go on continuously with the automatic devices without regard to night or day, noon hour or work hour, fair weather or storm, and this regularity is found to be very desirable and essential to the economical workings of the plant, for by its means the greatest possible effectiveness is obtained from any given contact bed or filter.

Mr. Alvord gives some valuable data concerning cost, but this must necessarily depend greatly upon local conditions. Given, however, the capacity and extent of a plant, it is altogether practicable to determine beforehand the cost of sewage purification for any given locality, and thus render the financial side of the subject a definite matter.

The two great sources of disease are undoubtedly to be found in impure water and in the presence of organic sewage, and these two are very frequently combined. With the purification of sewage before it is discharged into streams, and the filtration of water after it is taken from them, danger from these two sources may be practically eliminated, and a corresponding advance realized in the protection of the health of the community.

Some Resources of the United States.

In an interesting address read at the celebration of the twenty-fourth anniversary of the founding of the Engineers' Club of Philadelphia, Mr. John Birkinbine called attention to the magnitude of the resources of the United States in a manner well designed to impress his listeners with the enormous active and latent wealth of the country, as well as the share which the engineer has contributed to its increasingly rapid exploitation.

The estimated wealth of the United States is approximately one hundred thousand millions of dollars, or an average of $1,300 per capita of population. The output of coal is more than three-quarters of a million long tons per day, while the annual product of pig iron reaches 16,000,000 tons, requiring the mining of more than 29,000,000 tons of ore. The yearly output of gold and silver exceeds $100,000,000 in value, and this is about equalled by the value of the annual production of copper. Lead, zinc, and similar metals are represented by a yearly value of $40,000,000, and as a whole, the mineral products of the United States in 1901 attained a grand total value of $1,000,000,000.

One of the most impressive facts in connection with this vast array of natural resources is the extent to which mechanical appliances have been adapted to their exploitation. Thus, a single mining enterprise produces a million and a half tons of marketable product a year, transports this 100 miles, delivers it into vessels which carry it about 1,000 miles, and these vessels are discharged by mechanical appliances, so that the bulk of the iron ore is never touched by hand from the time it was lying in its bed until it is converted into metal. This is but a single example of the part which the work of the engineer has placed in developing the great natural wealth of the country.

"The farmer looks to the engineer for his agricultural machinery and those in the arid regions for dams and irrigating ditches which make possible the growth of crops on what would otherwise be barren soil. The miner depends on the engineer for the designing of shafts, laying out adits, drifts, and gangways, in equipping mines with ventilating and hoisting machinery, and in transporting the mineral won. All over the country there are evidence of the influence which the work and study of the engineer have exerted upon its development, and the position which he has occupied is one which brings honor to the profession and credit to the nation."

THE ENGINEERING INDEX

THE ENGINEERING INDEX IS THE KEYSTONE OF APPLIED SCIENCE

The following pages form a DESCRIPTIVE index to the important articles of permanent value published currently in about two hundred of the leading engineering journals of the world,—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every article.

(1) The full title,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published.

We supply the articles themselves, if desired.

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer and works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of any article referred to in the Index, together with all illustrations, can be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the journals indexed are given.

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CIVIL ENGINEERING

BRIDGES.

Arch Girder.

The Graphical Statics of Arched Girders. (Zur Graphischen Statik der Bogenträger) T. Stark. Giving the strain diagrams for a hinged arch in simple and convenient form. 1500 w. Zeitschr d Oesterr Ing a Arch Ver—March 21, 1902. No. 47726 B.

Defective Construction.

Defective Bridge Construction in the Prairie States. Daniel B. Luten. An illustrated article describing a type of steel bridge called the leg bridge, and noting its defects. 1800 w. Eng News—April 17, 1902. No. 47551.

Girders.

A Simple Method of Calculating Continuous and Constrained Beams. Edward Godfrey. Explains rule deduced from the three-moment formula and illustrates its application. 1100 w. Eng News—April 17, 1902. No. 47556.

Parallel Girders. F. H. Hummel. Read before the Civil and Mech. Engrs. Soc. Illustrates and describes parallel girders, giving their history and method of calculating weights in the present article. 3000 w. Prac Engr—April 18, 1902. Serial. 1st part. No. 47699 A.

Iron Bridges.

The Strengthening of Early Iron Bridges. The present article discusses the

We supply copies of these articles. See page 487.

need of inspection and considers floors, cast-iron girders and suspended bowstring girders. 3300 w. Engr. Lond—April 11, 1902. Serial. 1st part. No. 47601 A.

Painting.

The Painting and Sand-Blast Cleaning of Steel Bridges and Viaducts. George W. Lilly. Read before the Engrs' Club of Columbus, O. Describes a method of plastering the metal with a coating composed of Portland cement, red lead, and linseed oil. 6500 w. Eng News—April 24, 1902. No. 47668.

Piers.

High Concrete Piers for Railway Bridge Across Stone's River; Tennessee Central Ry. Illustrations with brief description of piers 65½ ft. high. 400 w. Eng News—March 27 1902. No. 47254.

Reinforced Concrete.

Concrete-Steel Arch Y-Bridge at Zanesville, O. Illustrated detailed description of this unusual bridge and its construction. 2500 w. Eng News—March 27, 1902. No. 47258.

See Civil Engineering, Materials.

Specifications.

Notes on Massachusetts Railroad Commissioners' Bridge Specifications. Gives some of the more important details of the specifications drawn by Prof. George F. Swain for bridges carrying electric railways. 2500 w. St Rv Jour—April 5, 1902. No. 47412 D.

Swing Bridges.

The Non-Continuous Swing Bridge; Two Existing Structures of This Type. Illustrates details of two bridges of this type built about ten years ago. 1000 w. Eng News—April 3, 1902. No. 47462.

Trans-Caspian Ry.

The New Bridge Over the Amou Daria River on the Trans Caspian Railway. A. Zdiarski. Describes the temporary wooden bridge and the permanent structure which is 5,250 ft. long, having 25 through spans of 210 ft. Ill. 2500 w. Eng News—April 10, 1902. No. 47509.

Viaducts.

The Chesapeake & Ohio Railroad Bridge at Richmond, Va. Illustrated description of double-track plate-girder viaduct 12,810 ft. long and a truss bridge 4,000 ft. long. The unusual method of erection by means of a steel cantilever traveler with an overhang of 142 ft. is fully explained. 3000 w. Eng Rec—March 29, 1902. No. 47202.

The Riverside Drive Viaduct Over Ninety-sixth Street, New York. Illustrated description of a short skew cantilever highway bridge. 2700 w. Eng Rec—April 12, 1902. No. 47477.

CANALS, RIVERS AND HARBORS.

Breakwaters.

Breakwaters and Plans for Breakwater Extension at Agate Bay, Two Harbors, Minn. S. M. White. Gives briefly the history of early examples, discussing the resistance to be overcome, manner of destruction, modern methods of construction, &c., the conditions at Agate Bay, and the work there. Ill. 9300 w. Jour Assn of Engng Socs—March, 1902. No. 47621 C.

Coast Protection.

The Lighting and Buoying of Coasts. (L'Eclairage et le Balisage des Côtes). M. Ribière. A review of recent progress in lighthouse engineering with especial reference to French practice. 15000 w. Ann d Ponts et Chaussées—4 Trimestre, 1901. No. 47718 E+F.

Dams.

An Estimate for Rebuilding the Austin Dam. Interesting part of a report and estimate submitted on March 24, to the Board of Water & Light Commissioners of Austin, Tex. 1500 w. Eng News—April 3, 1902. No. 47460.

Earthen Dams. Reginald E. Middleton. A letter on the relative merits of masonry and puddle for the cores of high dams. 1600 w. Eng Rec—March 29, 1902. No. 47209.

The Bohio Dam. Discussion of the paper by George S. Morison. Maps. 10,800 w. Pro Am Soc of Civ Engrs—March, 1902. No. 47218 E.

Docks.

Notes Collected in Relation to Docks and Harbors in Great Britain, France and Belgium in the Summer of 1900. Frank W. Hodgdon. A summary of information collected during a trip. Ill. 10000 w. Jour Assn of Engng Socs—March, 1902. No. 47618 C.

Dredges.

Light Draft Hydraulic Dredge. Illustrated detailed description of a dredge designed for special work on the coast of the Gulf of Mexico. Also describes the dredging machinery, propelling machinery and steam plant. 2000 w. Marine Engng—April, 1902. No. 47267 C.

Modern Dredging Machinery. (Neuere Baggerkonstruktionen.) R. Wels. Describing especially the improved suction dredges used in America, Russia, Australia and elsewhere. Two articles, 7500 w. Zeitschr d Ver Deutscher Ing—March 22, 29, 1902. No. 47708 each D.

Erie Canal.

The Improvement of the Erie Canal. An illustrated article explaining the bill now before the legislature, calling for the appropriation of $30,000,000 to be devoted

to the reconstru tion of the locks, and the relocation of the canal at certain points. 1800 w. Sci Am—April 26, 1902. No. 47657.

Galveston.

Plans for the Prot ction of Galveston from Floods. Gives the principal features of the plan adopted, and abstract of the engineers' report, with drawings. 2500 w. Eng News—April 24, 1902. No. 47673.

Government Work.

Some Needed Reforms in the Conduct of River and Harbor Work. Extracts from an address by Hon. Theodore E. Burton, setting forth some of the evils attendant upon the present method of providing for and carrying on river and harbor works. 2500 w. Eng News—April 17, 1902. No. 47553.

Harbor Works.

The Seaham Harbor Extension Works. Reviews the history of this coal port and describes the extensions to meet the requirements of trade. 1200 w. Engr, Lond —March 28, 1902. No. 47454 A.

Isthmian Canal.

A Bit of the "Ancient" History of the Isthmian Canal Problem. John Meikle. An account, with map, of a survey made about the middle of the nineteenth century for a canal across the isthmus of Darien. 2300 w. Sci Am Sup—March 29, 1902. No. 47228.

Sandy Coasts.

Grasses as Sand and Soil Binders. Abstract of a paper by Prof. H. Lamson-Scribner, giving the best available data upon the protection of sandy coasts from waves and winds. Ill. 1500 w. Eng News—April 24, 1002. No. 47672.

Tidal Basins.

Tidal Scour in Harbors, or the Function of Tidal Basins with Special Reference to the Harbor of Boston. Joseph P. Frizell. Also discussion. 5300 w. Jour Assn of Engng Socs—Feb., 1902. No. 47213 C.

CONSTRUCTION.

Building Construction.

A Successful Fire Test of Concrete-Steel Factory Construction. Describes the condition of a 200x250 ft. concrete-steel building after a serious fire within it. 1000 w. Eng Rec—April 12, 1902. No. 47474.

Composite Structures. An account of tests made of buildings which did service at the recent Paris Exposition, especially the Pavilion of the Republic of San Marino, a system of reinforced brick work and concrete with interwoven cores. The economy of material combined with resistance to all kinds of demolition could hardly be exceeded. 2800 w. Engng—March 21, 1902. No. 47290 A.

The Construction of the Hanover Bank Building, New York. Illustrates and describes the method of constructing pneumatic foundations and erecting steel-work of a 22-story office building. The details of a large steel derrick are shown. 2000 w. Eng Rec—April 12, 1902. No. 47473.

The Flatiron Building, New York. Illustrated description of the unusual structural steel details of a 21-story office building, triangular in plan and exposed to wind on all sides. 4800 w. Eng Rec—March 29, 1902. No. 47206.

The New Jersey Law Regulating Architectural Practice. The text of a law requiring all architects practicing in the State to be licensed by a State Commission. 1800 w. Eng. Rec—April 26, 1902. No. 47650.

Loads and Working Stresses for Austrian Building Work. Gives the unit stresses adopted by the Austrian Society of Engineers and Architects after an investigation covering two years. 600 w. Eng Rec—April 5, 1902. No. 47328.

Bricklaying.

Bricklaying at the British Westinghouse Works. J. C. Stewart, in the London *Times*. Explains the method adopted to double and triple the rate of bricklaying per man in Great Britain. 1700 w. Eng Rec—March 29, 1902. No. 47208.

Chimneys.

Chimney Design. Charles L. Hubbard. Reviews methods of determining the dimensions of chimneys. Ill. 1800 w. Engr, U S A—April 1, 1902. No. 47354.

Fireproofing.

The Conflagration at Paterson, N. J., February 8 and 9, 1902. An illustrated description of this disastrous fire and a discussion of the lessons to be learned from it. 4000 w. Br Build—March, 1902. No. 47260 D.

Foundations.

Lifting and Underpinning a Nine-story Wall. Describes the method of raising a 9-story wall of an office building nearly two inches and underpinning it without injury to the masonry or disturbance to the alignment of the elevators and other machinery. 1200 w. Eng Rec—April 19, 1902. No. 47614.

The Substructure Work for the Mutual Life Building New York. Illustrated description of the method of sinking small pneumatic cylinders and of underpinning heavy walls with girders on cylinder piers. 4300 w. Eng Rec—April 19, 1902. Serial. 1st part. No. 47611.

Grain Elevator.

A Concrete Grain Elevator. Illustrated description of a storage house embodying

the concrete and wire mesh system with steel tie rods as an additional strengthening. It is also unique in shape and size. 1600 w. Ir Age—April 3, 1902. No. 47318.

The Operation of the Modern Grain Elevator. D. A. Willey. An illustrated account of the construction and operation of the modern "tank" elevators for storing and handling grain. 3000 w. Engineering Magazine—May, 1902. No. 47775 B.

Jetties.

Single Curved vs. Double Straight Jetties. Lewis M. Haupt. An application of natural laws to the removal of bars. 1700 w. Jour Fr Inst—April, 1902. No. 47396 D.

Retaining Wall.

A New Design of Concrete-Steel Retaining Wall. Illustrated description of a construction patented by Frank A. Bone. 700 w. Eng News—March 27, 1902. No. 47252.

Sliding Embankments. (Fliessende Hänge) Max Singer. A description of the yielding of the sides of a railway cutting in the Eger valley, in Austria; with the methods employed for retaining the embankment. 4500 w. 1 plate. Zeitschr d Oesterr Ing u Arch Ver—March 14, 1902. No. 47725 B.

Road Rollers.

Oil Engine Road Rollers. Illustrated description of a successful application of oil engines to road rollers. Two of these engines have been used in France for two years. 800 w. Engr, Lond—March 21, 1902. No. 47304 A.

Roads.

Economical Methods of Road Improvement in the South. Charles H. Scott. Describes treatment given roads in North Carolina which proved both satisfactory and economical. 1800 w. Eng News—March 27, 1902. No. 47256.

Improvements in Tests of Macadam Materials. Describes experiments to standardize tests of the resistance to abrasion and of the cementing power of different stones. 2300 w. Eng Rec—April 19, 1902. No. 47608.

Methods of Reducing the Cost of Contractors' Work on Road Construction. Halbert Powers Gillette. Concerning certain economies that will reduce the cost of macadam road construction. 1800 w. Eng News—March 27, 1902. No. 47257.

Recent State Road Construction in Massachusetts. Describes mainly the methods adopted in preparing sub grades for broken stone and gravel roads. 1600 w. Eng Rec—April 5, 1902. No. 47325.

Steel-Work.

The Murray Iron Works Company's Boiler Shop. Illustrated description of the structural steel-work in a 425x190-ft. boiler shop. 3000 w. Eng Rec—April 5, 1902. No. 47324.

Subways.

The Pennsylvania Avenue Subway and Tunnel, Philadelphia, Pa. George S. Webster and Samuel Tobias Wagner. An illustrated article presenting features of interest in connection with this work. 21000 w. Pro Am Soc of Civ Engrs—March, 1902. No. 47215 E.

Tunneling.

A Rock Slide on the New York Rapid Transit Railway. Describes the recent accident in constructing a tunnel 60 ft. below the surface, which resulted in the collapse of several house fronts. 1500 w. Eng Rec—March 29, 1902. No. 47203.

Cave-In at the Park Avenue Rapid Transit Tunnel. Brief illustrated account of the accident which wrecked valuable property between 37th and 38th streets on Park avenue, New York City. 700 w. Sci Am—March 29, 1902. No. 47226.

The Aspen Tunnel. A. W. Clapp. Interesting features in the construction work of this tunnel of the Union Pacific R. R. in Wyoming are described and illustrated. 1400 w. Eng & Min Jour—April 12, 1902. No. 47503.

The Extension of the Orleans Railroad in Paris. Illustrated description of the method of driving a double-track railway tunnel with a roof shield. 1600 w. Eng Rec—April 5, 1902. No. 47323.

The Park Avenue Tunnel Cave-In. Illustrated description of the cause of the accident and the method decided upon to repair the trouble. 1100 w. Sci Am—April 5, 1902. No. 47382.

The Progress on the East Boston Tunnel. Describes the method of driving a tunnel by means of two advance drifts for the side walls and a roof shield for the arch. 1300 w. Eng Rec—April 19, 1902. No. 47610.

MATERIALS.

Basalt.

Basalt and Its Uses in Engineering Construction. An illustrated article describing this material and the uses to which it has been successfully applied. 2800 w. Quarry—April 1, 1902. No. 47529 A.

Cements.

The Addition of Puzzolana to Portland Cement (Addition de Pouzzolanes aux Cimente Portland). R. Feret. An examination of experiments showing the advantages of the addition of puzzolana to cement used in maritime work. 3000 w. 1 plate. Ann des Ponts et Chaussées—4 Trimestre, 1901. No. 47720 E+F.

The Classification of Crystalline Cements. Edwin C. Eckel. Formulates a classification believed to be rational and practical. It is based primarily upon the

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amount of chemical change caused by the processes of manufacture and use; and secondarily upon the chemical composition after setting. 2400 w. Am Geol—March, 1902. No. 47430 D.

The Structure of Cementing Materials. W. Carrick Anderson. Read before the Sci. Soc. of the Glasgow & W. of Scotland Tech. Col. Presents much information on the chemistry of these materials, reporting valuable investigations. 8000 w. Quarry—April 1, 1902. No. 47530 A.

Reinforced Concrete.

The Computation of Monier Beams. (Beitrag zur Berechnung der Monierplatten). Max K. v. Thullie. A review of the methods of Barkhausen and Considère, with application of computations of actual examples of concrete steel construction. 2000 w. Zeitschr d Oesterr Ing u Arch Ver—March 28, 1902. No. 47727 B.

See Civil Engineering, Bridges.

Steel Protection.

The Chemistry of the Protection of Steel Against Rust and Fire by Concrete. Extracts from an article by Prof. Spencer B. Newberry, read before the Assn. of Expanded Metal Cos.' at Chicago, summarizing the chemical and physical laws supporting the belief that concrete is an efficient covering. 1000 w. Eng News—April 24, 1902. No. 47670.

Tests.

Weight Tests of Concrete Arches. Report of some recently conducted weight tests on various types of arches designed by Jacob Schratwieser which show remarkable results. Ill. 2200 w. Ins Engng—March, 1902. No. 47273 C.

Wood Preservation.

Preservative Processes for Woodwork. H. C. Standage. Gives various processes covering almost every case of wood requiring preservatives from exceptional decaying influences. 4200 w. Builder—April 12, 1902. No. 47579 A.

MEASUREMENT.

Measuring Distances.

Measuring Cloud Distances from a Railway Train. A brief description of the conditions that are involved, with the method of determination. 1300 w. Eng News—March 27, 1902. No. 47253.

Metre.

The Metric Convention (La Convention du Mètre). C. E. Guillaume. Discussing the influence of variations in gravitation upon the establishment of standards, also the use of light wave-lengths as invariable references. 10,000 w. Bull Soc d'Encour—March, 1902. No. 47723 G.

Photography.

Photography as Applied to Architectural Measurement and Surveying. J. Bridges Lee. Indicates the great possibilities of accurate photography and the lines along which the development should progress. Ill. 6000 w. Jour Soc of Arts—April 18, 1902. No. 47698 A.

Road Survey.

Preliminary Road Surveys in Maryland. Describes the nature and cost of the work of the Maryland Geological Survey. 900 w. Eng Rec—April 12, 1902. No. 47476.

Surveying.

Some Devices for Increasing the Accuracy or Rapidity of Surveying Operations. Discussion of the paper by Walter Loring Webb. Ill. 13600 w. Pro Am Soc of Civ Engrs—March, 1902. No. 47217 E.

Surveying Instruments.

Remarks upon Surveying Instruments, with Special Reference to the Paper of Mr. Dunbar D. Scott on the Evolution of Mine-Engineering Instruments, and to its Discussions. H. D. Hoskold. Ill. 8400 w. Trans Am Inst of Min Engrs—Nov, 1901. No. 47538 D.

Theodolite.

The Hammer-Fennel Tachymeter-Theodolite (Der Hammer-Fennel 'sche Tachymeter-Theodolit). J. Stambach. Description of an improved stadia theodolite for topographical surveying. 2000 w. Schweizerische Bauzeitung—March 29, 1902. No. 47743 B.

Tide Gage.

Indicating and Recording the Tides. Day Allen Willey. Illustrates and describes the instruments used by the United States government for predicting, recording and indicating the fluctuations of the tide. 1700 w. Sci Am—April 12, 1902. No. 47470.

MUNICIPAL.

Destructors.

A British Refuse Lighting Plant. Illustrates and describes the plant to supply the Burgh of Partick, near Glasgow, in which the destructor plant furnishes the principal source of heat for raising steam. 2000 w. Elec Wld & Engr—April 26, 1902. No. 47676.

Partick Municipal Electricity and Destructor Works. Illustrated description of buildings and plant costing about £6,500. 2300 w. Elect'n, Lond—March 28, 1902. No. 47439 A.

Great Britain.

Sanitary Betterment in Great Britain. From the address of Dr. John C. Thresh, before the Inst. of San. Engrs, Great Britain. A review of the history of the sanitary movement in England. 4000 w. Dom Engng—April 15, 1902. No. 47630 C.

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Municipal Population.

Methods of Estimating Population. Abstract of a paper by Walter F. Wilcox. Discusses the relative accuracy of different methods of estimating population of cities in the United States, as demonstrated by comparisons of the methods with the results of Federal censuses. 3700 w. Eng Rec—March 22, 1902. No. 47040.

Pavements.

Robbia Pavement. Allan Marquand. An illustrated article giving information in regard to the Robbia work, both in relation to pavements and sculptural monuments, showing simila designs. 1600 w. Br. Build—March, 1902. Serial. 1st part. No. 47259 D.

Public Works.

Public Works Administration. John A. Fairlie. Gives the leading features of public works administration in some of the leading cities of the United States. 3000 w. Munic Engng—April, 1902. No. 47272 C.

Refuse C emation.

A House-Refuse Incinerator for New York City. Illustrated description of a crematory constructed on a timber pier for burning wood, paper and similar refuse. 1400 w. Eng Rec—April 19, 1902. No. 47612.

Proposed Light Refuse Crematory for New York City. Illustrated detailed description of a proposed plant to be built on the dumping pier for New York City by the Department of Street Cleaning. 1600 w. Eng News—April 17, 1902. No. 47555.

Sewage.

Bacterial Purification of Sewage. B. H. Buxton. Outlines the changes which take place in sewage when treated by bacterial methods. 3300 w. Eng Rec—April 26, 1902. No. 47646.

Sewage Purification and Water Pollution in the United States. Gives a list of 95 cities and towns where some means of treating the sewage is practiced, with remarks on methods in use. 2000 w. Eng News—April 3, 1902. No. 47461.

Sewage Disposal.

German Experiments with Sewage Treatment by Septic Tanks and Contact Filter Beds. Reports results of experiments extending over 3½ years. 900 w. Eng News—April 10, 1902. No. 47510.

Management of the Septic Tank. Extracts from a paper read before the Royal Inst. of Public Health. Discusses the objects of careful management of septic tanks and contact beds. 3300 w. Dom Engng—April 15, 1902. No. 47631 C.

The New Sewage Disposal Works at Gardner, Mass. Illustrated description of coke strainers and intermittent filters, with automatic apparatus for discharging sewage over them, operating at 150,000 gallons per acre daily on the filters. 2300 w. Eng Rec—April 12, 1902. No. 47472.

The New Sewage Disposal Works at Pittsfield, Mass. An illustrated description of the new plant to take the place of the temporary outlets into the Housatonic River. 1800 w. Eng News—April 24, 1902. No. 47671.

The Present Status of the Sewage Problem in England. Report of a lecture by L. P. Kinnicutt on current British opinion concerning septic tanks, contact beds and intermittent continuous filters. 1600 w. Eng Rec—March 29, 1902. No. 47205.

Sewers.

A Reinforced Concrete Sewer. Illustrated description of an 8x14-ft. sewer wholly of concrete, the roof being strengthened by concrete-steel beams. 300 w. Eng Rec—April 12, 1902. No. 47475.

Washington, D. C.

Beautifying the Nation's Capital. An illustrated article discussing new bridges to be built to replace what is called the "Long bridge." 4200 w. In Archt—March, 1902. No. 47239 D.

WATER SUPPLY.

Dams.

The Construction of the Wachusett Dam. Illustrated description of the plant and methods employed in constructing a masonry dam 850 ft. long and 207 ft. high. 4300 w. Eng Rec—April 5, 1902. No. 47322.

The Proportions of Reservoir Dams. (Beitrag zur Dimensionierung der Thalsperrenmanern). G. Ramisch. Developing formulas for the stability of masonry dams, tabulating the values for various dimensions. 1800 w. Zeitschr d Oesterr Ing u Arch Ver—April 4, 1902. No. 47728 B.

Purification.

Water Purification for Domestic Use. F. Rigaud. Discusses methods of sterilization of water, and other considerations that must be taken into account. Especially favoring the ozone process. 3000 w. Min & Sci R—April 5, 1902. No. 47484.

Water-Works.

A Kindergarten Lesson in Water Supply. An account of Jersey City's experience in buying water-works and water rights from a contractor without itself preparing plans. 1200 w. Eng Rec—April 12, 1902. No. 47471.

The Fire Protection Obligation of Water Companies. Reviews a decision of the Kentucky Court of Appeals, holding that a water company can be sued by the owners of property destroyed through inadequate water supplies for fire protection. 900 w. Eng Rec—March 29, 1902. No. 47201.

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ELECTRICAL ENGINEERING

COMMUNICATION.

Cable Testing.

A Modified Mance Test. J. H. Strong. Explanatory of the method of eliminating the error due to earth current in localizing faults in submarine cables. 200 w. Elect'n Lond—March 28, 1902. No. 47440 A.

Exchanges.

Exchange Construction. W. H. Crumb. Read before the Interstate Independent Tel. Assn. Considers points of importance in good construction. 2200 w. Telephony—April, 1902. No. 47496.

Space Telegraphy.

An Induction Cost for X-Light Tubes and Wireless Telegraphy. William Rollins. An illustrated article giving directions which will enable anyone possessing mechanical skill to construct a seventy-centimetre induction coil suitable for the powerful currents needed in wireless telegraphy and in X-light work. 3500 w. Elec Rev, N Y—March 29, 1902. No. 47235.

Long-Distance Telegraphy and Marconi's Latest Experiments. Fernand Poucelet. An examination of Marconi's experiment in sending a signal between the Lizard and Newfoundland, with the aim of judging what will be the future of wireless telegraphy over the ocean. Ill. 3500 w. Elec Engr, Lond—April 18, 1902. Serial. 1st part. No. 47805 A.

Tesla's Work and Marconi's. From the *New York Sun*. Quotes from a lecture by Tesla delivered in 1893, and notes, the acknowledgement by Prof. A. Slaby that Tesla is the inventor of the process of wireless telegraphy. 2500 w. Elec, N Y—April 9, 1902. No. 47463.

The Marconi Wireless Telegraph System in Canada. Wilfrid Blaydes. An account of the agreement considering the fourteen clauses *seriatim*. 2000 w. Elec Wld & Engr—March 29, 1902. No. 47248.

The Telephone in Wireless Telegraphy. Emile Guarini. Part first gives illustrated descriptions of various methods of wireless signaling. 1200 w. Elec Wld & Engr—April 5, 1902. Serial. 1st part. No. 47417.

Wireless Telephony. A. Frederick Collins. Explains five distinct methods for transmitting speech without wires at varying distances. 1200 w. Elec Wld & Engr—April 5, 1902. No. 47418.

Wireless Telegraphy and Submarine Cables. E. Guarini. An illustrated article discussing Mr. Mervyn O'Gorman's idea, that the coherer might render valuable service to submarine cables. 1200 w. Elec Rev, Lond—March 21, 1902. Serial. 1st part. No. 47288 A.

Wireless Telegraphy in Spain. E. Guarini. An account of the experimental work of Señor Julis Cervera Baviera, with description of the instruments used, tests, &c. Ill. 2300 w. Elect'n, Lond—April 18, 1902. No. 47810 A

Wireless Telegraphy: Mr. Marconi's Short-Distance Work in Europe and America. Wilfrid Blaydes. A brief account of the extent to which this part of the work has been developed. Ill. 2400 w. Elec Wld & Engr—April 5, 1902. No. 47421.

Telephony.

A Modern Central Energy Bell Telephone Exchange. Illustrated description of the new common battery exchange at Mt. Vernon, N. Y. 1200 w. Am Elect'n—April, 1902. No. 47374.

An Independent Central Energy Exchange and Toll Line Office. An illustrated description of the exchange at Alton, Ill., which is a part of a scheme to give long-distance service to the cities of Missouri and Southern Illinois. 1400 w. Am Elect'n—April, 1902. No. 47378.

The Evolution of the Message Rate Telephone Service. Herbert Laws Webb. Reviews the progress before and since the adoption of the message rates. 2200 w. Elec Wld & Engr—April 5, 1902. Serial. 1st part. No. 47420.

The Technical Development of Telephony. Kempster B. Miller. A rapid review of the development. 3500 w. Telephony—April, 1902. No. 47495.

Underground.

Underground Conductors for the Municipal Telephone System of the German Post Office. (Unterirdische Führung von Anschlussleitungen in Stadfernsprechnetzen der Deutschen Reischpost). H. Zappe. A fully illustrated description of the underground system recently installed in Berlin. 5000 w. Elektrotech Zeitschr—April 10, 1902. No. 47755 B.

DISTRIBUTION.

Conductors.

A Rapid Method of Computing the Regulating Resistance for Electric Lighting Conductors (Praktische und Schnelle Berechnung der Widerstands regulatoren für Licht leitungen). P. Gesing. Deducing a simple formula and providing full tables for practical use. 2000 w. Elektrotech Zeitschr—April 3, 1902. No. 47750 B.

We supply copies of these articles. See page 487.

The Cost of Electrical Conductors. (Beitrag zur Kostenberechnung Elektrischer Leitungen). L. W. Cohn. Discussing the use of a formula in which the unit cost and character of the conductor are given, and the cost for any required service may be determined. 1000 w. Elektrotech Zeitschr—March 27, 1902. No. 47748 B.

Grounding.

Grounding of High Potential Systems. J. D. Nies. The aim of the paper is to determine what are the causes to which the existence of danger may be ascribed, with special reference to the occasional practice of grounding the point of zero e. m. f. in such systems. Also editorial. 3300 w. Elec Wld & Engr—April 12, 1902. No. 47505.

Insulation.

A Study of Insulating Compounds. This first article deals with shellac. 1200 w. Cent Sta—April, 1902. Serial. 1st part. No. 47371.

Mains.

The Mains Department of a Direct-Current Electricity Supply Station. J. F. Moore. Sketches the different characteristics of the several classes of cable, discusses localization of faults, meters, &c. 3800 w. Elec Engr, Lond—April 11, 1902. No. 47585 A.

Paris.

The Sections of Electrical Distribution in Paris (Les Secteurs de Distribution d'Electricité à Paris). C. Marquet. The first of a series describing the character and extent of electrical distribution under the various concessions in Paris. Serial. 1st part. 2500 w. Génie Civil—March 22, 1902. No. 47701 D.

Wiring.

Electric Wiring Methods of To-day. Fred. Bathurst. Discusses this subject with especial reference to conduit systems. 3800 w. Elec Rev, Lond—April 11, 1902. No. 47588 A.

The Wastes of Wiring. J. Whitcher. Means of reducing waste are discussed. 2000 w. Elec Engr Lond—April 4, 1902. No. 47425 A.

ELECTRO-CHEMISTRY.

Accumulators.

The Max Accumulator. From *La Locomotion.* Illustrated detailed description of this new system. The electrodes have a cylindrical form. 1000 w. Sci Am Sup—April 19, 1902. Non. 47562.

Acker Process.

The Acker Electrolytic Alkali Process. Clinton Paul Townsend. Reviews the work of prior investigators, and compares this process with the Castner-Kellner mercury cathode process. Ill. 2300 w. Elec Wld & Engr—April 5, 1902. No. 47419.

Electro-Metallurgy.

Recent Developments in the Electro-Metallurgy of Iron and Steel. Marcus Ruthenberg. Considers the magnetic concentration of low-grade ores in the electric furnace; describes the Conley electric steel-smelting process for the production of steel direct from the ore; and the Harmet process for the production of steel direct from the ore. Ill. 3000 w. Electro-Chem & Met—March, 1902. No. 47563 A.

Germany.

The Electrochemical Metal Industries of Germany. (Von der Elektrochemischen Metall-Industrie Deutschlands). H. Danneel. A review of the present conditions of the electrochemical production of metals, with data as to export quantities, and methods of operation. 3000 w. Zeitschr f Electrochemie—March 6, 1902. No. 47757 D.

Graphite.

Artificial Graphite and Platino-Iridium as Materials for Anodes (Ueber Künstlichen Graphit und über Platiniridium als Anodenmaterialen). F. Foerster. Data and results of experiments to determine the durability of anodes of artificial graphite under various conditions. 2500 w. Zeitschr Elektrochemie—March 6, 1902. No. 47758 D.

Hargreaves-Bird.

Hargreaves-Bird Process for the Electrolytic Production of Soda and Bleach. Edward Walker. Illustrated detailed description of the works and plant, with account of the principles of the process. 1500 w. Eng & Min Jour—April 5, 1902. No. 47402.

Ionisation.

Ionisation of Gases by Ionic Shock. J. Stark. Abstracted from *Ann. der Physik.* Explains the ionic theory and the work in this field. The object of the paper is to find theoretical guides for experimental work. 3800 w. Elect'n, Lond—March 21, 1902. No. 47289 A.

Manganese.

The Determination of the Melting Point of Manganese (Schmelzpunktsbestimmung von Mangan). W. C. Heraeus. A description of the use of electric fusion methods by which the melting point of manganese is found to be 1245 degrees centigrade. 1200 w. Zeitschr f Elektrochemie—April 3, 1902. No. 47759 D.

Niagara Falls.

The Electro-Chemical Industries at Niagara Falls. Abstract of a lecture by Prof. Joseph W. Richards before the N. Y. Elec. Soc. describing the manufacture of

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aluminum, the Acheson carborundum and graphite, the Castner sodium process and caustic soda process, the manufacture of carbide, and the Salom lead reduction process. 2800 w. Ir Age—April 3, 1902. No. 47319.

Polarization.

Electrochemical Polarization. C. J. Reed. Concludes that polarization is a progressive change in the composition and electromotive force of an electrochemical system necessitated by the progressive exhaustion of one or more of the electrochemical reagents. 3500 w. Jour Fr Inst—April, 1902. No. 47395 D.

ELECTRO-PHYSICS.

Alternating Currents.

Apparatus for the Demonstration of Alternating Currents (Apparat zur Demonstration von Wechselströmen). Dr. R. Heilbrun. Describing the construction of a lecture room model, with revolving arms and disc, enabling the sine-curve phenomena to be mechanically produced before an audience. 1000 w. Elektrotech Zeitschr—March 20, 1902. No. 47745 B.

Electromagnets.

The Distribution of Magnetic Flux in Large Electromagnets. W. M. Thornton. Read before the Newcastle Soc. of the Inst. of Elec. Engrs. Describes a method giving precise knowledge of the flux at any desired point of the circuit and of its variation with magnetizing current or with time. It has been the aim to do for magnetic observations what the indicator diagram does for engine testing. 5000 w. Elec Engr, Lond—April 11, 1902. Serial. 1st part. No. 47586 A.

Electronic Theory.

The Electronic Theory of Electricity. Dr. J. A. Fleming. A sketch of this theory showing the evolution of the idea that electricity is atomic in structure, and thus these atoms of electricity called electrons attach themselves to material atoms and are separable from them. 9800 w. Pop Sci M—May, 1902. No. 47651 C.

Electrons.

Note on the size and Inertia of Electrons. Oliver Heaviside. A review of the work that has been done in determining the physical constants of the electron. 700 w. Elect'n, Lond—April 4, 1902. No. 47427 A.

Lightning.

Lightning Above and Below Water. Prof. John Trowbridge. An illustrated account of experiments believed to show that lightning never strikes the surface of the sea. 1100 w. Sci Am—April 5, 1902. No. 47384.

Photographone.

Speaking Photography (Sprechende Photographien). H. Zacharias. Describing the apparatus by which the variations in an electric arc due to articulate sounds may be photographed on a moving film, and subsequently re-produced by means of a selenium cell and telephone. 2000 w. Glasers Annalen—March 15, 1902. No. 47731 D.

Radio-Conductors.

Single-Contact Radioconductors (Radioconducteurs à Contact Unique). E. Branly. A resumé of experiments with single contacts through a film of oxide. 1000 w. Comptes Rendus—Feb. 10, 1902. No. 47724 D.

Rotating Disks.

Condenser Effects with Rotating Disks. A. G. Dill. An account of experiments with description of apparatus used. 1000 w. Elec Wld & Engr—March 29, 1902. No. 47250.

Static Effects.

Static Strains in High Tension Circuits and the Protection of Apparatus. Percy H. Thomas. Discusses the "static effects" in high tension circuits, especial attention being given to the disturbances produced by lightning, switching, grounding, and the like. Ill. 19000 w. Trans Am Inst of Elec Engrs—March, 1902. No. 47568 D.

Thermo-Electricity.

Electricity and Power Direct from Heat. James Asher. Reviews some of the methods, the thermo-electric batteries, pyromagnetic generators, &c. 1500 w. Sci Am—March 29, 1902. No. 47224.

Waves.

Electric Waves in Wires (Elektrische Drahtwellen). G. Seibt. An examination of the action of electric waves in metallic wires, with reference to the utilization of electric waves in wireless telegraphy. Serial. Part 1, 4000 w. Electrotech Zeitschr—April 10, 1902. No. 47754 B.

GENERATING STATIONS.

Alternators.

Parallel Operation of Alternators. Paul M. Lincoln. Discusses this subject and describes a new synchronism indicator invented by the writer, and the principles upon which it rests. Ill. 5300 w. Jour Fr Inst—April, 1902, No. 47394 D.

The Phase Displacement of Alternators and Parallel Running. H. C. Leake. Deals with the effect of periodic fluctuation of the turning moment of the prime mover. 1500 w. Elec Rev, Lond—April 4, 1902. Serial. 1st part. No. 47524 A.

Armatures.

The Phenomena in Double-Current Armatures (Ueber die Vorgänge in Wechselstromdurchflossenen Gleichstromankern). L. Fleischman & A. Orgler. An examination of the occurrences in ring armatures

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from which both continuous and alternating currents are taken. 2000 w. Elektrotech Zeitschr—March 27, 1902. No. 47747 B.

Coal Question.

The Coal Question in Generating Stations. Discusses the cause of such wide variation in prices, and gives a brief study of the varieties in use. 3800 w. Elec Times—April 3, 1902. No. 47532 A.

Commutator.

How Many Commutator Sections Should Be Used in a Continuous-Current Dynamo? (Wieviel Kollektorlamellen Soll eine Gleichstrommaschine Haben?) A. Rothert. An examination of the construction of the commutators of continuous-current dynamos, showing the method of computing the proper number of sections. 6000 w. Elektrotech Zeitschr—April 10, 1902. No. 47752 B.

Cornwall.

A Novel Central Station at Cornwall. An illustrated article describing this recently completed station in Canada, of special interest because of illuminating the locks and their approaches on the Cornwall Canal, thus permitting the passage of ships day and night. 800 w. Cent Sta—April, 1902. No. 47370.

Dynamos.

The Operation of Two or More Dynamos Together. B. T. McCormick. Discusses the cases of dynamos in parallel, the three-wire system, and dynamos in series explaining the reasons. Mathematical. 900 w. Elec Rev, N Y—April 5, 1902. No. 47401.

Generators.

Running Direct-Current Generators in Parallel. John H. Ryan, Jr. An illustrated article discussing economical running at all loads. 3000 w. Engr, U S A—April 1, 1902. Serial. 1st part. No. 47356.

Synchronous Reactance. F. G. Baum. Presents a method showing the probable error due to using the synchronous reactance in computing the effect of regulation. 800 w. Elec Wld & Engr—April 26, 1902. No. 47675.

Hydro-Electric.

A Small Water Power Electric Transmission Plant for Local Lighting Service, Utah County, Utah. W. P. Hardesty. Illustrated description of a plant as an example of what can be done in the way of utilizing the natural fall of many mountain streams for the benefit of neighboring settlements. 1800 w. Eng News—April 17, 1902. No. 47549.

Notes on Irish Water-Power and Its Electrical Development. W. Tatlow. Abstract of a paper read before the Dublin Local Section of the Inst. of Elec. Engrs. A general survey of water-power that can commercially be made available, with descriptions of a few places. 3000 w. Elect'n, Lond—April 4, 1902. No. 47528 A.

Isolated Plant.

A Central Station Isolated Plant. Illustrated detailed description of the plant of the Peruna Drug Mfg. Co., of Columbus, O. Interesting because of the high-class of the installation, diversity of service, and special devices and their applications. 3500 w. Elec Wld & Engr—April 26, 1902. No. 47674.

Municipal Works.

Middleton Electric Lighting and Tramways. Illustrated descrintion of small supply works recently opened in England. 1600 w. Elect'n, Lond—April 11, 1902. No. 47583 A.

Parallel Operation.

Parallel Operation of Engine-Driven Alternators. W. L. R. Emmet. Explains a method of overcoming the difficulties of surging which has been in successful use for three years. 2500 w. Trans Am Inst of Elec Engrs—March, 1902. No. 47575D.

Polyphase.

Some Notes on Polyphase Machinery. A C. Eborall. Read before the Manchester Sec. of the Inst. of Elec. Engrs. Considers the construction and operation of standard types, discussing the latest development. Ill. 3000 w. Elec Rev, Lond—April 18, 1902. Serial. 1st part. No. 47808 A.

Power Supply.

Electric Power Supply on the Northeast Coast. C. S. Vesey Brown. Read before the Newcastle Section of the Inst. of Elec. Engrs. A brief retrospect of the history of electric power supply in England, with views on the equipment of power stations, and the possibilities which will probably follow their instalment. 4500 w. Elec. Engr, Lond—March 21, 1901. No. 47286 A.

Regulation.

The Regulation of Prime Movers and Parallel Operation of Alternators. Charles P. Steinmetz. Considers features regarding the effect of speed regulation of prime movers, and difficulties with parallel operation of alternators driven from separate prime movers. 1200 w. Trans Am Inst of Elec Engrs—March, 1902. No. 47574 D.

Rhyl Works.

The Rhyl Electricity Works. An illustrated description of dynamos, engines, boilers, steam-pipes, switchboard, cables and arc lamps used. 2000 w. Elec Engr, Lond—March 28, 1902. No. 47437 A.

Sparking.

Sparking—It's Cause and Cure. Arthur L. Rice. A study of injurious sparking considering its cause, effects, and location

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of the trouble. Ill. 2500 w. Engr, U S A—April 1, 1902. No. 47353.

Swiss Plant.

Electrical Works of the Maschinenfabrik Oerlikon. Frank C. Perkins. Illustrates and describes details of this great Swiss plant. 2500 w. Mach, N Y—April, 1902. No. 47423.

Tariffs.

The Influence of Tariffs on Electricity Supply. C. Ashmore Baker. Commences an examination of undertakings to ascertain the influence the various methods of charging for electrical energy may exert on the load factors and financial results. 800 w. Elec Rev, Lond—March 21, 1902. Serial. 1st part. No. 47287 A.

HEATING AND WELDING.

Electric Furnaces.

A Modification of the Moissan Furnace (Uebereinen Modifizierten Moissanschen Schmelzofen). L. Liebmann. A detailed illustrated description of an improved electric furnace especially adapted for laboratory use. 1800 w. Zeitschr f Elektrochemie—Feb. 27, 1902. No. 47756 D.

Some Recent Electric Furnace Products. Clinton Paul Townsend. Concerning the methods for the pulverization of metals in the electric furnace and the nature of the products obtained. 900 w. Elec Wld & Engr—April 5, 1902. No. 47422.

LIGHTING.

Boulevard Lighting.

The Lighting of Diversey Boulevard, Chicago. J. R. Cravath. Illustrates and describes one of the best recent examples of boulevard lighting in the United States. The lamps are series direct-current enclosed arcs, taking 6.2 amperes at 72 volts. 1200 w. Am Elect'n—April, 1902. No. 47377.

Illumination.

The Art of Design for Electric Illumination; Domestic and Public. Fred T. Cash. Comments on the great improvement made in fixtures for interior lighting, and criticises the designs for public lighting. 2000 w. Elec Rev, Lond—April 11, 1902. No. 47587 A.

Nernst Lamp.

Development of the Nernst Lamp in America. Alexander Jay Wurts. Discussion at Buffalo, Aug. 23, 1901. 6800 w. Trans Am Inst of Elec Engrs—March, 1902. No. 47570 D.

Tests on the Nernst Lamp, R. P. Hulse. Read before the Birmingham Sec. of the Inst. of Elec. Engrs. Reports tests made of the 1902 model. 2800 w. Mech Engr—April 5, 1902. No. 47531 A.

MEASUREMENT.

Conductivity.

The Commercial Measurement of Electrical Conductivity. Lawrence Addicks. A review of the methods and apparatus for the measurement of conductivity and a brief discussion of their respective merits. 3300 w. Elec Rev, N Y—April 12, 1902. No. 47504.

Photometry.

An Improved Apparatus for Arc Light Photometry. Discussion of a paper by Dr. Matthews at New York, Sept. 27, 1901. 3000 w. Trans Am Inst of Elec Engrs—March, 1902. No. 47573 D.

Transformation.

Ratio of Transformation in Three-Phase Circuits. William A. DelMar. Calls attention to the changes in ratio of transformation that can attend the various methods of connecting sectional transformers with three-phase circuits. Mathematical. 600 w. Elec Wld & Engr—April 19, 1902. No. 47645.

Voltmeters.

An Apparatus for the Rapid Comparison of Voltmeters. F. A. Laws and W. D. Coolidge. Describes apparatus used at the Mass. Inst. of Tech. for comparing direct current voltmeters with a standard instrument. Ill. 1300 w. Tech Qr— March, 1902. No. 47816 E.

Zero Method.

Zero Method for Magnetic Measurements (Nullmethode für magnetische Messungen). R. Goldschmidt. Discussing applications of the method of determining the magnetic force of given windings by the use of auxiliary windings producing induced currents in opposite directions. 1200 w. Elektrotech Zeitschr—April 10, 1902. No. 47753 B.

POWER APPLICATIONS.

Cranes.

Electric Locomotive Crane (Ein Elektrisch Betriebener Locomotivguss Krahn). C. Machacek. An illustrated description of a traveling locomotive crane operated by electric power taken from an overhead trolley. 2500 w. 2 plates. Oesterr Zeitschr f Berg u Hüttenwesen—March 15, 1902. No. 47767 B.

Electric Power for Forge Cranes (Elektrische Drehvorrichtung für Schmiedekrähne). A. Willaredt. A description of a new electric crane for use in connection with forging presses at the Cockerill Works at Seraing. 1200 w. Stahl u Eisen—April 1, 1902. No. 47738 D.

Magnetic Brakes. Gerald E. Flanagan. An illustrated explanation of the action of magnetically operated brakes as used on cranes and hoisting machinery. 700 w. Am Mach—April 10, 1902. No. 47488.

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Modern Electric Hoists and Cranes for Steel Works. Dr. A. Krebs. Illustrated description of an installation in a new Belgian foundry. 700 w. Elec Wld & Engr—March 29, 1902. No. 47251.

Haulage.

Electric Haulage in Coal Mines. W. B. Clarke. Brief illustrated description of plant, with general remarks. 1400 w. Elec Wld & Engr—March 29, 1902. No. 47247.

Machine Driving.

Influence of Electricity in Shops. Cloyd Marshall. An illustrated article reviewing the advantages and showing machines operated by electricity. 2000 w. Engr, U S A—April 1, 1902. No. 47355.

Mining Plant.

A Polyphase Electric Power Plant, and a Direct-current Power Plant. Illustrates and describes two recently installed plants at English collieries, comparing the two. 4000 w. Col Guard—April 11, 1902. No. 47593 A.

Mexican Electric Power Distribution to the Santa-Rosalia Copper Mining near the Gulf of California. Frank C. Perkins. Illustrations with description of the plant. 2000 w. Min Rept—April 10, 1902. No. 47508.

Sparkless Electrical Plant for Use in Mines and Ironworks. Abstract of a paper by J. H. Whittaker read at meeting of the South Staffordshire and East Worcestershire Inst. of Min. Engrs. 2700 w. Col Guard—April 18, 1902. No. 47692 A.

The Electro-Mechanical Plant at the Tunnel of the Raibl Mine (Der Elektro-Maschinelle Betrieb des Neues Hilfstolleng für den Ararischen Erzbergbau in Raibl). A. Edlen von Posch. Describing the electric drills and other machinery used in running the auxiliary tunnel of the Raibl mines in Carinthia, Austria. Four articles. 7500 w. Oesterr Zeitschr f Berg u Hüttenwesen—March 8, 15, 22, 29, 1902. No. 47766 each B.

Motors.

Characteristic Performance of the Induction Motor. A. S. McAllister. Discusses the ordinary polyphase induction motor, its characteristic behavior as built at present, starting devices, etc 2200 w. Am Elect'n—April, 1902. No. 47375.

Continuous Current Motors with Variable Speed (Ueber Gleichstrommotoren mit Veränderlich Umdrehungszahl). A. Hundt. The variation in speed is effected by varying the air gap between the poles and the armature. 1200 w. Elektrotech Zeitschr—March 20, 1902. No. 47744 B.

Synchronous Motor Stability and Overload Capacity Curves. F. G. Baum. Considers some important factors influencing the stability and overload capacity of motors, giving method of determining curves. 1800 w. Elec Wld & Engr—March 29, 1902. No. 47249.

Motor Tests.

Tests of Polyphase Motor (Untersuchung eines Drehstrommotors). E. Ziehl. Data and results of tests of a polyphase motor built by the Berlin Maschinenbau A. G., with curves showing efficiency and capacity under various conditions. 3500 w. Elektrotech Zeitschr—March 20, 1902. No. 47744 B.

United States.

The Position of the United States in the Production of Electric Power. Sidney Graves Koon. Tables and diagrams with facts showing the enormous preponderance of the United States in every department of this field. 1300 w. Sib Jour of Engng—March, 1902. No. 47057 C.

TRANSMISSION.

Cables.

Air-Spaced Cables: Their Treatment and Use. G. E. Fletcher. Read before the Manchester Sec. of the Inst. of Elec. Engrs. Considers the conditions and precautions necessary for the production of air-spaced paper insulated cables and the question of protecting them from the destructive effect of lightning, recommending their use. 2000 w. Mech Engr—April 19, 1902. No. 47801 A.

High Potential.

Discussion of President Steinmetz's Paper on "Oscillations of Extremely High Potentials in Alternating High Potential Transmissions." Communicated after adjournment by Percy H. Thomas. 900 w. Trans Am Inst of Elec Engrs—March, 1902. No. 47572 D.

Legislation.

Electric Legislation and Finance. H. W. Handcock. Read before the Newcastle Section of the Inst. of Elec. Engrs. Discussion of these subjects as related to the practical application of electricity in England. 5000 w. Elec Engr. Lond—Feb. 28, 1902. No. 46714 A.

New Zealand.

Electric-Power Transmission Plant at Rotorua. Oswald Haes. An illustrated description of a recently installed long-distance plant in New Zealand. 6300 w. N Z Mines Rec—March 18, 1902. No. 47811 B.

Niagara Falls.

The Electric Transmission of Power from Niagara Falls. Lewis B. Stillwell. Discussion at Buffalo, Aug. 23, 1901. 5000 w. Trans Am Inst of Elec Engrs—March 1902. No. 47569 D.

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GAS WORKS ENGINEERING

Acetylene Lamps.

Experiments with Acetylene Lamps for Pit Work. Abstract of a paper by G. Franke, of Berlin, showing that at present these lamps require more careful usage than is given by the average miner. Reports of tests are given. Ill. 1200 w. Col Guard—March 21, 1902. No. 47306 A.

Benches.

I. Is There Any Economy in Full Depth Benches Over Half-Depth; and Why? D. R. Russell. II. Isolated Generator Firing of Benches. W. E. Steinwedell. Two papers, discussed together, presented at meeting of the Ohio Gas Lgt. Assn. 3500 w. Am Gas Lgt Jour—April 28, 1902. No. 47686.

Candle-Power.

Notes on Candle-Power Determinations. Charles W. Hinman. Read before the New England Association of Gas Engrs. A report of tests and of a novel method of taking candle power. 2700 w. Am Gas Lgt Jour—March 31, 1902. No. 47243.

China.

Natural Gases and Observations Concerning Gas Lights in the Chinese Empire. Sketches of work in progress in the natural gas section of China, with descriptive notes. 1700 w. Am Gas Lgt Jour—April 7, 1902. No. 47413.

Conveyors.

More About the "De Brouwer" Conveyor. Extracts from an article by P. Bolsius describing improvements made in this apparatus. Ill. 1500 w. Jour Gas Lgt—March 25, 1902. No. 47425 A.

Enrichment.

The Use of Oil in Water Gas, Coal Gas and Air Gas Production. Vivian B. Lewes. A sketch of the history of water gas and air gas manufacture, showing the importance of oil in the generation of these gases. 7000 w. Jour Gas Lgt—April 1, 1902. No. 47468 A.

Explosive Mixtures.

Explosive Gas Mixtures. A review of paper by Dr. H. Bunte, read before the German Soc. of Gas and Water Engrs. and containing much information regarding the theoretical facts involved in the construction of atmospheric gas burners and of gas engines. 1500 w. Engr, Lond—March 28, 1902. No. 47451 A.

Mixtures of Combustible Gases and Air. Gives results of experiments, published recently in German technical papers, to determine the range of proportions in which gases and air can be mixed so as to remain explosive. 800 w. Eng Rec—April 19, 1902. No. 47613.

Fuel Gas.

Fuel Gas for Domestic Use and Small Trade Purposes. Thomas Fletcher. The first of a series of articles on the application of gaseous fuel to heating purposes, with editorial. 5800 w. Jour Gas Lgt—April 15, 1902. Serial. 1st part. No. 47655 A.

Producer Gas and Its Use in Engineering and Shipbuilding. F. J. Rowan. Read before the Inst. of Engrs. & Shipbuilders in Scotland. Explains the advantages of this method of treating fuel, giving illustrated descriptions of modern types of producers. 2800 w. Mech Engr—March 22, 1902. Serial. 1st part. No. 47282 A.

The Economy of Gas-Fired Furnaces. F. J. Rowan. Abstract of paper read before the Inst. of Engrs. and Shipbuilders in Scotland. Considers the furnaces found especially useful in engineering and shipbuilding. Ill. 2000 w. Ir & Coal Trds Rev—March 21, 1902. No. 47297 A.

High Pressure.

Distributing Artificial Gas at High Pressure in a Suburban Locality. George F. Goodnow. Read before the Boston meeting of the New England Assn. of Gas Engrs. Describes the methods used by the North Shore Gas Co. in the suburban district near Chicago. Ill. 3300 w. Pro Age—April 1, 1902. No. 47271.

Distribution of Gas Under High Pressure. F. H. Shelton. Paper and discussion presented at meeting of the Ohio Gas Lgt. Assn. Ways in which it enables saving in expenses, or improvement in service, or extension. 5500 w. Am Gas Lgt Jour—April 28, 1902. No. 47684.

The Distribution of Artificial Gas Under High Pressure. Describes the methods adopted in Chicago suburbs to save the expense of large pipe lines. 1800 w. Eng Rec—April 12, 1902. No. 47478.

History.

A Brief History of Street Gas. Reviews the early history of gas as an illuminant. 900 w. Sci Am—April 5, 1902. No. 47381.

Illuminations.

Artistic Electrical Illumination. Edwin O. Sachs. Read before the Soc. for the Encour. of the Fine Arts. Reviews briefly illumination appliances used in the past, discussing gas illumination and electric lighting boards. 4800 w. Elec Rev, Lond—April 11, 1902. No. 47589 A.

Incandescence.

The Chemistry of Thorium. Summary of a paper by Dr. G. P. Drossbach, pub-

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lished in the *Zeitschrift für Angewandte Chemie*. Methods of determining the value of the rare earths now so much used. 1200 w. Jour of Gas Lgt—April 1, 1902. No. 47649 A.

Lamps.

High-Power Gas Lamps and Their Cost. Reviews what has recently been accomplished by the "high pressure" system, discussing the cost. 1300 w. Builder—March 22, 1902. No. 47277 A.

Meters.

The "Positive" Meter. John Greenall, before the Eastern Counties Gas Mgrs. Assn. An illustrated article explaining the fundamental principles and working, and giving report of tests. 3600 w. Gas Wld—April 19, 1902. No. 47804 A.

Mond Gas.

The Mond Gas Process (Mond-Gas). A description of the Mond gas process, in which the cost of power gas is reduced by the saving of the by-products. 3000 w. Glückauf—March 15, 1902. No. 47763 B.

Natural Gas.

Natural Gas in Colorado. Arthur Lakes. An illustrated description of some of its occurrences and the conditions which point to the probability of its existence. 2200 w. Mines & Min—April, 1902. No. 47337 C.

Oil Gas.

Oil Gas and Incandescent Lighting. Third lecture by Prof. Vivian B. Lewes at the Petroleum Inst. Abstract. Discusses commercial results, processes, costs, etc. 3600 w. Gas Wld—April 19, 1902. No. 47802 A.

Radiation.

The Laws of Radiation of Heat and Light. Summary giving the leading points of a series of papers by Rudolph Mewes, in the *Zeitschrift für Beleuchtungswesen*. 1200 w. Gas Wld—March 22, 1902. No. 47279 A.

Residuals.

Some Notes on the Working Up of Gas Works Residuals. The present paper deals with tar distillation. 1700 w. Gas Wld—March 29, 1902. Serial. 1st part. No. 47432 A.

Supply.

Boston and Its Gas Supply. J. S. Dongall, before the Eastern Counties Gas Mgrs. Assn. Details and early history of the supply to this English seaport. 1200 w. Gas Wld—April 19, 1902. No. 47803 A.

Water Gas.

Carburetted Water Gas. How it affects the distributing plant, burners, cookers, etc., and the remedies, 1500 w. Gas Engrs' Mag—March 10, 1902. No. 47278 A.

The Loomis Gas Plant. Illustrated description of the water gas plant designed by the Loomis Pettibone Company of New York, which has been much improved over the first designs. 1800 w. Ir & Coal Trds Rev—March 21, 1902. No. 47299 A.

INDUSTRIAL ECONOMY

Coal Supplies.

Some Problems in Relation to Our Coal Supplies. Remarks of Prof. Archibald Elliott, contributed to the discussion of a paper by J. Stephen Jeans. The subject of Great Britain's supply is considered from a mathematical point of view. 3800 w. Ir & Coal Trds Rev—April 11, 1902. No. 47590 A.

The Misuse of Coal. W. Hibbert. Remarks on suggestions of Prof. Perry, with review of a work on "Primary Batteries." 2200 w. Elec Rev, Lond—April 18, 1902. No. 47809 A.

Exhibition.

The Düsseldorf Exhibition. Brief illustrated description of the iron, steel, and engineering industries. 1500 w. Engng—March 21, 1902. No. 47291 A.

The Rhenish-Westphalia Exposition of 1902 at Düsseldorf (Rheinisch-Westfälische Industrie Gewerbe-und Kunstausstellung, Düsseldorf, 1902). A fully illustrated description of the Düsseldorf exposition just prior to the opening, with map. 3500 w. Stahl u Eisen—April 1, 1902. No. 47736 D.

Factory Office.

The Factory Office Considered as a Productive Department. Kenneth Falconer. Mr. Falconer's second paper shows the true relation of the factory office to the stores department and the shops. 3500 w. Engineering Magazine—May, 1902. No. 47778 B.

Labor.

Compensation of Skilled Labor. J. Richards. Discussion of this subject by one who is himself a practical workman and who has had large experience in directing work and arranging compensation, etc. 6500 w. Jour Assn of Engng Socs—March, 1902. No. 47617 C.

Steel Trust.

Steel Trust Expansion. Comment on the earnings of the past year production in Sweden, and the purchase of the

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control of the Gellivara mines by an American combine. 1500 w. Engr, Lond —April 11, 1902. No. 47603 A.

Trusts.

The Trusts and Their Effect on the Business World. Charles Kirchoff. Read before the Philadelphia Foundrymen's Assn. Considers the effect of consolidation upon the manufacturing industries; how they are to deal with the growing competition, etc. 3500 w. Ir Age—April 17, 1902. No. 47744.

Works Management.

Money Making Management for Workshop and Factory. C. V. Carpenter. Mr. Carpenter's fourth paper discusses in detail the systematic arrangement and operation of the stock department of a factory. 5000 w. Engineering Magazine—May, 1902. No. 47773 B.

MARINE AND NAVAL ENGINEERING

Battleship.

The French Coast Defence Battleship Requin. An illustrated description of this reconstructed battleship which has been brought well up to date in construction and equipment. 800 w. Engr, Lond—March 21, 1902. No. 47303A.

The French Reconstructed battleship Courbet. Illustrated description of the modifications introduced in the vessel and armament. 350 w. Engr, Lond—April 11, 1902. No. 47602 A.

Combination.

A Great Steamship Combination. Information obtained from Clement A. Griscom concerning the recent combination of six lines by J. Pierpont Morgan, and what they propose to accomplish. 2200 w. Marine Rev—April 24. 1902. No. 47683.

Corrosion.

Corrosion of Condenser Tubes and Sea-Water Conductors. Prof. Ernst Cohen. Read before the Inst. of Naval Archts. An acount of researches and the remedies recommended. Ill. 2000 w. Mech Engr —April 19, 1902. No. 47800 A.

Crank-Shafts.

Strains on Crank-Shafts. Prof. S. Dunkerley. Read before the Inst. of Naval Archts. Considers the straining action on the different parts of a crank-shaft, illustrating by an actual case of a four-cranked marine shaft. Ill. 3700 w. Engng—March 28, 1902. Serial. 1st part. No. 47450 A.

Cruisers.

Repairs and alterations to the U. S. S. Olympia. William P. Robert. An illustrated article describing the extensive repairs made to bring the vessel thoroughly up to its fighting efficiency, and to refit and adorn it in memory of the prominent part it took at Manila. 5000 w. Marine Engng—April, 1902. No. 47624 C.

Destroyer.

The Repair of the Torpedo-Boat Destroyer "Salmon." Illustrated description of interesting reconstruction of a vessel almost cut in two transversely by a collision. 2500 w. Engng—March 21, 1902. No. 47292 A.

Torpedo-Boat Destroyer S. W. Barnaby. Read before the Inst. of Naval Archts. A discussion of this type of vessel as used in the British Navy, as to seaworthiness, strength, &c. 3400 w. Engng—March 21, 1902. No. 47295 A.

Economy.

The Growth of Economy in Marine Engineering. W. M. McFarland. Mr. McFarland's third paper deals with the multiple expansion engine and the great advances in economy which followed its introduction. 4000 w. Engineering Magazine—May, 1902. No. 47774 B.

Ferryboat.

New Screw Ferryboat. An illustrated description of the "Edgewater," the latest to be built for New York waters. 1800 w. Naut Gaz—April 24, 1902. No. 47661.

Floating Dock.

The New Bermuda Floating Dock. H. J. Stepstone. Illustration with description of this latest equipment to the British Navy. 1200 w. Sci Am—April 5, 1902. No. 47383.

Fortresses.

Ceuta and Gibraltar. Major-Gen. John F. Crease. Discusses the value of these strongholds, especially considering the impregnability of Gibraltar. Maps. 1400 w. Jour Soc of Arts—April 11, 1902. No. 47577 A.

Freighters.

Types of Ocean Freighters for the Foreign Trade. Theodore Lucas. An illustrated review of types of ships used principally for the carrying trade between the United States and foreign countries. 1800 w. Naut Gaz—April 17, 1902. No. 47628.

Liquid Fuel.

On Liquid Fuel for Ships. Sir Fortesque Flannery, with discussion before the Inst. of Naval Archts. Considers the supply, and the comparative advantages and disadvantages for war vessels and for

the mercantile ships. Ill. 6600 w. Engng —March 28, 1902. No. 47449 A.

Merchant Marine.

Manning the Merchant Marine. Theodore Lucas. Discusses steps taken by different nations to foster the interest for the sea in young men and inspire them with a healthy ambition in the work. 1500 w. Naut Gaz—March 27, 1902. No. 47229.

Naval Engineers.

The Status of the Naval Engineer. Charles M. Johnson. A strong presentation of the dangers of the existing status of the engineering branch in the British Navy, showing the urgent necessity of reform. 5000 w. Engng Mag—May, 1902. No. 47776 B.

Naval Warfare.

Recent Scientific Developments and the Future of Naval Warfare. William Laird Clowes. Read before the Inst. of Naval Archts. An appeal for greater official interest in recent inventions, and education for those who are to use the tools. 2600 w. Engr, Lond—March 28, 1902. No. 47453 A.

Navipendulum.

The Navipendular Method of Experiments, as applied to Some Warships of Different Classes. G. Russo. Read before the Inst. of Naval Archts. Gives results of experiments and comparative tests of the rolling of certain battle ships. 6400 w. Engng—April 18, 1902. Serial. 1st part. No. 47691 A.

Primitive Vessels.

From Raft to Steamship. Randolph I. Geare. The present article illustrates and describes the earliest forms of vessels. 1300 w. Sci Am Sup—April 5, 1902. No. 47386.

Rudders.

Rudders. J. Foster King. Read at Glasgow Meeting of Inst. of Engrs. & Shipbuilders in Scotland. Discusses types of rudders in use in normal vessels of the merchant service. Ill. 6400 w. Naut Gaz—April 3, 1902. No. 47358.

Schooner.

Modern Five-Masted Schooner. James A. Hargan. Illustrates and describes the large steel sailing vessels being built at Bath, Me. 1700 w. Marine Engng—April, 1902. No. 47266 C.

Shaft Bearings.

Improvements in Propeller Shaft Bearings. A. Scott Younger. Read before the Inst. of Naval Archts. The objects of the paper are to record some results of experiments, and present some improvements in propeller shaft bearings, and other improvements. Ill. 3300 w. Engr, Lond—March 28, 1902. No. 47456 A.

Shipping.

Shipping Portents. Editorial discussion of the commercial requirements and the attitude of the various countries. 2600 w. Engng—March 14, 1902. No. 47084 A.

Ship Subsidy.

How Various Countries Subsidize Their Mercantile Marine. Editorial on the various means adopted by European nations to encourage their mercantile marine. 1000 w. Sci Am—March 8, 1902. No. 46690.

Ships' Plates.

Stresses on Ships' Plates. Ivan G. Boobnoff. Read before the Inst. of Naval Archts. An illustrated study of the stresses in a ship's bottom plating due to water pressure, giving a system of construction that the writer recommends. 4600 w. Engng—March 21, 1902. No. 47296 A.

Shipyards.

Recent Operations in the Shipyards on the Great Lakes. Waldon Fawcett. An illustrated article reviewing the work since the opening of the year 1901. 2200 w. Marine Engng—April, 1902. No. 47265 C.

The Electrical Equipment of a Modern Shipyard. Illustrated detailed description of the fine plant of the Fore River Ship and Engine Co., at Quincy, Mass. 3000 w. Elec Rev, N Y—April 26, 1902. No. 47667.

Signal Apparatus.

The New Signal Apparatus of the Union Electrical Company (Die Neuen Signalapparate der Union Elektricitäts Gesellschaft). E. Henbach. An illustrated description of an improved electrical apparatus for signalling from the bridge of a vessel to the engine room. 5000 w. Elektrotech Zeitschr—April 3, 1902. No. 47751 B.

Steamships.

Steamship Lines of the World. An enumeration of the leading steamship lines of the most important countries, with illustrations of four representative American steamships. 5400 w. Naut Gaz—April 17, 1902. No. 47629.

The Screw Steamship "Sithonia" (Der Schraubendampfer "Sithonia.") An illustrated description of the new steamer of 13,500 tons, built by the Flensburg Works for the Hamburg-America China trade. 2500 w. 1 plate. Zeitschr d Ver Deutscher Ing—April 12, 1902. No. 47716 D.

Turbine Engines.

Turbine Engines for Passenger Ships. Notes on the "King Edward." An illustrated article discussing the performance of the turbine engines, and concluding that they are destined to play an important part in the propulsion of steamships. 1500

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w. Sci Am Sup—April 5, 1902. No. 47388.

Vibrations.

Torsional Vibrations of Shafts. L. Gumbel. Read before the Inst. of Naval Archts. A study of the torsional vibrations of the shafts of marine engines by the aid of Fourier's Theorem. 4600 w. Engng—April 11, 1902. No. 47595 A.

Yachts.

German Emperor's Yacht Meteor III. An illustrated account of the launching and brief description of the vessel. 1000 w. Marine Engng—April, 1902. No. 47268 C.

The Arrow, Fastest Steam Vessel in the World. Jefferson S. Briggs. An illustrated detailed description of this recently built twin-screw yacht, intended to attain the highest possible speed. The design and construction of the hull and machinery are of particular interest. 3800 w. Sta Engr—April 15, 1902. No. 47626.

MECHANICAL ENGINEERING

AUTOMOBILES.

Alcohol.

Alcohol for Automobiles. R. F. Collins. Discusses the headway made in France and Germany in the use of alcohol as a fuel for motor vehicles. 1200 w. Auto Mag—April, 1902. 47274 C.

The Spirit-Locomotive Wagon in Germany. Concerning competitive prizes offered for these vehicles, giving synopsis of specifications and points to be considered in the competition. 900 w. U S Cons Repts. No. 1322—April 22, 1902. No. 47606 D.

Automobiles.

Automobiles. Hiram Percy Maxim. Discusses the real field of the automobile, especially in urban or city transportation. 2200 w. Am Mfr—April 3, 1902. No. 47360.

Cleaning.

The Automobilist's Spring Cleaning. Albert L. Clough. Suggestions relating to the preparation of motor vehicles which have been out of use, for their period of activity. 2500 w. Horseless Age—March 5, 1902. No. 46666.

Construction.

Some French Novelties. L. Berger. Illustrated review of automobiles shown at the recent exhibition in Paris. 900 w. Horseless Age—Feb. 26, 1902. No. 46508.

Endurance Contest.

Rules and Regulations of the 100-Mile Endurance Contest of the A. C. A. A statement of eighteen rules governing the contests. 2300 w. Horseless Age—March 12, 1902. No. 46894.

Exhibits.

The Leipsic Automobile Show. Illustrations and descriptions of various types exhibited with general remarks. 1500 w. Sci Am Sup—April 26, 1902. No. 47659.

Flash Boilers.

Flash Steam Generation. Charles F. Ruby. Considers points in the design of a successful flash boiler, materials to be used, construction, &c. 1400 w. Horseless Age—April 2, 1902. Serial. 1st part. No. 47320.

Fuel Tests.

Fuel Tests of Automobile Vehicles (Epreuves de Consommation pour Voitures Automobiles). Data and results of various trials, with especial reference to internal combustion motors using alcohol and essence. 1200 w. Génie Civil—March 22, 1902. No. 47702 D.

Heavy Hauling.

Requirements for Heavy Hauling. Gives the requirements specified in the competition instituted by the German Government. 2000 w. Auto Topics—April 12, 1902. No. 47464.

Land Yacht.

A Boat on Wheels. John L. von Blon. Illustrates and describes a novel sail propelled vehicle which has been in service on the western desert for eight months. 900 w. Sci Am—April 19, 1902. No. 47560.

Mors Car.

The 15 H. P. Mors. An illustrated description of the mechanism. 1200 w. Autocar—March 15, 1902. No. 47125 A.

Motor Bicycle.

Holden's Motor Bicycle. Illustrates and describes an ingenious invention exhibited at the Crystal Palace Motor Car Show. 1000 w. Engr, Lond—April 4, 1902. No. 47516 A.

Motor Trucks.

Motor Delivery and Trucking in New York City. Harry E. Day. Reports of various users in Greater New York, not very favorable to their efficiency. 5000 w. Horseless Age—April 16, 1902. No. 47545.

Nice.

The Automobile Meeting at Nice. An account of the meeting and illustrated

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descriptions of the new cars, and their trials and other matters of interest. 5500 w. Autocar—April 19, 1902. No. 47697 A.

Omnibuses.

Steam Omnibuses. Illustrates and describes types of the Thornycroft omnibuses. 900 w. Tram & Ry Wld—March 13, 1902. No. 47315 B.

Panhard-Levassor.

The New Light Panhard-Levassor Automobile. L. Baudryde Sannier, in *La Locomotion.* An illustrated detailed description. 3000 w. Sci Am Sup—March 1, 1902. No. 46557.

Petrol Car.

The New Twelve Horse-Power Humber Car. Illustrates and describes the engine and transmission. 1800 w. Autocar —April 12, 1902. No. 47580 A.

Serpollet.

Motor Vehicles with Serpollet Boilers. (Motorwagen mit Serpollet-Kesseln). H. Hempel. An account of the performance of the Serpollet steam motor vehicles in local tramway service. 1200 w. Zeitschr d Ver Deutscher Ing—March 29, 1902. No. 47712 D.

Steam Carriage.

Some Features of the Toledo Steam Carriage. Illustrates and describes features of interest. 2000 w. Horseless Age —April 16, 1902. Serial. 1st part. No. 47546.

Storage Batteries.

The Storage Battery in the Commercial Operation of Electric Automobiles. W. H. Palmer, Jr. Describes briefly the progress that has been made and the means employed to obtain economy and reliability in operation. Ill. 5200 w. Elec Wld & Engr—April 12, 1902. No. 47506.

Testing.

Automobile Testing as Thesis Work. Albert L. Clough. Indicates work which the laboratories of educational institutions might take up. 1200 w. Horseless Age—March 12, 1902. No. 46891.

Tires.

Tires and Automobile Design. F. A. Oatman. States the principal reasons for the unsatisfactory results obtained from tires, and expresses belief in the future of the solid rubber tire. 1900 w. Horseless Age—April 2, 1902. No. 47321.

Touring Car.

What a Light Touring Car Should Be. H. Ward Leonard. Lecture before the Long Is. Automobile Club. Considers nine important points that should be carefully investigated. 3400 w. Horseless Age—March 12, 1902. No. 47433.

Touring Outfit.

A Practical Automobile Touring Outfit. Hrolf Wisby. An article suggesting what should be, and should not be included. 2300 w. Sci Am—March 1, 1902. No. 46543.

War Car.

The Simms Motor War Car. Illustrated description of a car designed for coast and road defense. 1200 w. Autocar—April 12, 1902. No. 47581 A.

HYDRAULICS.

Back Water.

The Estimation of Damages to Power Plants from Back-Water. A decision of the Maine Supreme Court outlining the methods of ascertaining the damages caused by flashboards. 3500 w. Eng Rec —April 26, 1902. No. 47648.

Cranes.

Hydraulic Movable Warehouse Cranes. Illustrates and describes types made in Liverpool. 600 w. Engng—April 4, 1902. No. 47518 A.

Flow.

On the Measurement of Water by a Small Venturi Meter. E. G. Coker and T. P. Strickland. An account of experiments with illustrated description of apparatus used. 3800 w. Canadian Soc of Civ Engrs. Adv Proof—April, 1902. No. 47616 D.

Gate Valve.

An 8-inch Hydraulic Gate Valve on a Detroit Water Main Supplying River Rouge, Mich. George H. Fenkell. Illustrated description of an automatic hydraulic gate which has been in operation since 1900. 600 w. Eng News—April 17, 1902. No. 47552.

Lost Head.

Notes on Lost-Head in Water Supply Systems. A. Prescott Folwell. A mathematical discussion with conclusions. 2000 w. Eng News—April 17, 1902. No. 47550.

Plumbing.

Plumbing at the Sailors' Snug Harbor, Staten Island. Illustrated description of special work in hospital wards, a laundry, and a power house. 2600 w. Eng Rec—April 5, 1902. No. 47327.

Water Power.

The Elgin Water Power Decision. An opinion by the Illinois Supreme Court that a company managing the dam and raceways of several power users is without legal right to sue for damages caused by a diversion of water above the dam by other parties. 3000 w. Eng Rec—March 29, 1902. No. 47204.

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The Joliet Water Power Plant on the Chicago Drainage Canal. Illustrated description of a 7000 H. P. plant operating under an unusually low pressure, which makes it necessary to have six turbines coupled to the shaft of each main generator. 3000 w. Eng Rec—April 19, 1902. No. 47607.

Turbines and the Effective Utilization of Water-Power. Alex. Rea. Abstract of a paper read before the Salford Science Students' Assn. Illustrated descriptions of various types of turbines, discussing their construction. 2200 w. Mech Engr—March 22, 1902. Serial. 1st part. No. 47281 A.

MACHINE WORKS AND FOUNDRIES.

Bolt Cutter.

The Acme Automatic Unit Tapping and Bolt Cutting Machines. Illustrated descriptions of two interesting and valuable machines and their operation. 1600 w. Ir Age—April 3, 1902. No. 47317.

Boring Machine.

A Large Boring Machine. Illustrated description of a fine large machine for boring large engine beds, Corliss engine cylinders, frames for large pumping engines, and similar work. 5000 w. Engr, Lond—April 18, 1902. No. 47695 A.

Cost Keeping.

Analyzing Cost of Machinery Making. Oberlin Smith. Considering cost keeping in the manufacture of machinery. 2800 w. Ir Trd Rev—April 3, 1902. No. 47399.

Cranes.

See Electrical Engineering, Power Applications.

Dies.

Dies for Punching Leather Shoe Tips. Joseph V. Woodworth. Illustrates and describes means employed for punching elaborate designs in leather. 900 w. Am Mach—April 3, 1902. No. 47350.

Forges.

Fans and Piping for Forges. William Sangster. Suggestions as to the approximate cost of blowers and piping with hints on arranging. Ill. 1300 w. Am. Mach—April 24, 1902. No. 47666.

Foundry.

The Foundry of John Lang & Sons, Johnstone, Scotland. C. C. Macmillan. Illustrated detailed description of a fine modern foundry. 2500 w. Foundry—April, 1902. No. 47275.

Foundry Cupola.

The Foundry Cupola and How to Manage It. Robert Buchanan. Read before the Staffordshire Iron & Steel Inst. Describes the various forms, and discusses their management; also considers blast pressure, scaffolding and how to avoid it, scrap iron, charging, &c., &c. Discussion follows. 13000 w. Foundry—April, 1902. No. 47276.

Lathe.

The Patternmaker's Lathe. John M. Richardson. Illustrates and describes tools for the lathe. 1800 w. Am. Mach—April 3, 1902. No. 47349.

Machine Driving.

See Electrical Engineering Power Applications.

Machinery Protection.

Fencing or Guarding Machinery Used in Textile Factories, with Special Reference to Machinery Used by Cotton Spinners and Manufacturers. Samuel R. Platt. Illustrated descriptions of guards for textile machinery. 6 plates. 3000 w. Inst. of Mech Engrs—March 21, 1902. No. 47308 D.

Fencing of Steam and Gas Engines. Henry D. Marshall. Reviews the usual modern practice of furnishing protection to diminish risk of accidents to attendants, and offers suggestions for additional safeguards. Ill. 2000 w. Inst of Mech Engrs—March 21, 1902. No. 47307 D.

Guarding Machine Tools. W. H. Johnson. Considers the conditions fulfilled by a perfect guard, the materials used, and the ways of applying them. 3 plates. 1500 w. Inst of Mech Engrs—March 21, 1902. No. 47310 D.

Protection of Lift Shafts, and Safety Devices in Connection with Lift-Doors and Controlling Gear. Henry C. Walker. States conditions and describes a lift with ideal entrance doors, locks, and controlling apparatus. 3400 w. 3 plates. Inst of Mech Engrs—March 21, 1902. No. 47309 D.

Mechanical Device.

A Good Machinist With Only One Hand. C. W. Putnam. An illustrated article describing a device that enabled a good workman who had lost his left hand, to resume his place. 600 w. Am Mach—April 3, 1902. No. 47348.

Ordnance.

United Stat s Ordnance Factories. Waldon Fawcett. Brief illustrated descriptions of some of the government plants for the manufacture of naval and coast defense ordnance. 1500 w. Mod Mach—April, 1902. No. 47361.

Pipe Flanges.

Standardization of Pipe Flanges and Flanged Fittings. Robert E. Atkinson. An illustrated paper giving statements of

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sizes of pipe flanges, with number of bolts in use by several manufacturers in England, with similar particulars about general practice in Germany and America. Particulars and scale drawings of special joints, &c. 5400 w. Inst of Mech Engrs —April 18, 1902. No. 47687 D.

Planer.

The Bilgram Bevel-Gear Planer. Illustrations and descriptions of its construction and method of working. 3600 w. Engng—March 21, 1902. No. 47293 A.

Shops.

The Plant of the Bullock Electric Manufacturing Company and Its Work and Cost System. Illustrated detailed description of one of the finest modern plants, located near Cincinnati, and its methods. 5000 w. Ir Trd Rev—April 3, 1902. No. 47398.

The Works of the British Westinghouse Electric and Manufacturing Company. The present article describes the buildings of this large plant. The equipment will be dealt with in subsequent articles. Plans and illustrations are given. 2300 w. Engng—March 28, 1902. Serial. 1st part. No. 47448 A.

Surfacing.

The Surfacing Machine. Illustrated description of a new machine for facing tees, crosses and elbows. 900 w. Am Mach—April 24, 1902. No. 47665.

MATERIALS OF CONSTRUCTION.

Buckling.

The Buckling of Multiple Supported Rods (Die Knicklast Mehrfach Befestigter Stäbe). F. Wittenbauer. A mathematical investigation of the resistance to buckling of rods supported at several points, and subjected to endlong pressure. 2000 w. Zeitschr d Ver Deutscher Ing—April 5, 1902. No. 47715 D.

Corrosion.

The Corrosion of Copper Water-Pipes (Ueber Anfressungen Kupferner Wasserleitungen). H .Hüllmann. A discussion of the behavior of copper water conductors in vessels of the German Navy. 2000 w. Zeitschr d Ver Deutscher Ing—April 12, 1902. No. 47717 D.

Elasticity.

The Elastic Deformation of Solids (La Déformation Elastique des Solides). A. Mesnager. A comparison of the theoretical principles with the results obtained in the study of glass by polarized light. 12000 w. Ann des Ponts et Chaussées—4 Trimestre, 1901. No. 47719 E+F.

Gutta Percha.

Seeking Gutta-Percha. George E. Walsh. On the sources of supply, the prospect of forests of the trees in the Philippines, the advisability of cultivating the trees in suitable climates, &c. 1300 w. Elec Rev, N. Y—March 1, 1902. No. 46561.

Oil Extraction.

Extraction of Oil by Chemical Process. Information concerning the mechanical arrangements and the process used so successfully in France. 1200 w. U S Cons Repts, No. 1311—April 9, 1902. No. 47397 D.

Penetration.

The Resistance of Elastic and Non-Elastic Materials to Penetration (Résistance à la Penetration de Matiéres Elastiques on Non). E. Simon. A report upon the Persoz system of testing metallic and textile materials by penetration. 4000 w. Bull Soc d 'Encour—March, 1902. No. 47721 G.

Resistance.

The Dynamics of the Resistance of Materials (Beitrage zum Dynamischen Ausbau der Festigkeitslehre). H. Summerfeld. A discussion of the action of vibration in engineering structures, and its influence upon the resistance of materials of construction. 4000 w. Zeitschr d Ver Deutscher Ing—March 15, 1902. No. 47707 D.

Rope.

Rope. J. W. Walton. From a book issued by a Cleveland firm, giving interesting information concerning the processes of manufacturing, and the origin of wire rope. 4500 w. Marine Rev—March 13, 1902. No. 46876.

Stresses.

Stresses in Columns Subject to Combined Axial and Transverse Loading. Charles Worthington. Considers the conditions which generally exist in the designing of columns of this class, deducing formulas, &c. Ill. 2500 w. Pro Am Soc of Civ Engrs—March, 1902. No. 47216 E.

Test Bars.

The False Witness of the Test Bar. Robert Buchanan. Emphasizing the importance of obtaining correctly representative bars for testing the strength of cast iron, and showing the unsoundness of present accepted methods. 3000 w. Engineering Magazine—May, 1902. No. 47777 B.

Testing.

The Testing of Iron and Steel on Nicked Bars (Prufung von Eisen und Stahl an Eingekerbten Stucken). M. Rudeloff. A discussion of the value of the drop test

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of nicked bars for the determination of the resistance of iron and steel. Two articles. 7000 w. Stahl u Eisen—April 1, 15, 1902. No. 47737 each D.

Tool Steels.

Comparative Use of American and English Tool Steels in the Machine Shops of the United States. A symposium of opinions of a number of firms called out by a statement made concerning the use of English steel in American shops. 5500 w. Ir Trd Rev—March 6, 1902. No. 46760.

Wire.

Modern Practice and Its Result in the Drawing of Wire Rods into Wire. William Garrett. Describes the modern practice of drawing rods, with brief reference to earlier effort, mostly confined to American practice. 4400 w. Ir & Coal Trds Rev—April 11, 1902. No. 47591 A.

MEASUREMENT.

Omnimeter.

The Omnimeter Annex. W. A. Warman. Illustration and suggestions showing a few of the possibilities of this device as a time saver. 350 w .Am Mach—April 10, 1902. No. 47487.

Planimeters.

Description and Theory of Coradi's Rolling Ball Planimeter. J. W. Beardsley. Illustrated description of a labor-saving instrument of great usefulness. 3500 w. Jour Assn of Engng Soc—Feb., 1902. No. 47212 C.

Verniers.

The Reading of Verniers. An explanatory article. Ill. 1300 w. Am Mach—April 3, 1902. No. 47351.

POWER AND TRANSMISSION.

Bearings.

Roller Bearings. Paper read by Prof. Hele-Shaw before the Automobile Club of Great Britain and Ireland on this subject. Ill. 3500 w. Horseless Age—April 9, 1902. No. 47465.

The Lubrication and Formation of Surfaces for Bearings. John Dewrance. An illustrated article dealing with lubrication, reciprocating bearings, bearing surfaces, &c. 3000 w. Mech Engr—March 22, 1902. No. 47280 A.

Cableway.

The Cableway of the Hydro-Electric Plant at Vouvry (Transporteur Aérien sur Cables de l'Usine Hydro- Electrique de Vouvry). A. Boudon. A description of the method used in handling the material for a hydraulic pipe line in Switzerland, in steep and difficult country. 2000 w. Génie Civil—March 29, 1902. No. 47703 D.

Compressed Air.

The Freezing of Moisture Deposited from Compressed Air. Robert Peele. Considers the conditions that cause freezing, and devices to remedy the trouble. 1600 w. Mines & Min—April, 1902. No. 47336 C.

The Use of Compressed Air in Mining. T. W. Barber. States its special advantages and applications, discussing methods, the installation and improvements needed. 2600 w. Ir & Coal Trds Rev—April 4, 1902. No. 47521 A.

Yield of Air Compressors. J. Walter Pearse. Table and descriptive matter showing a general comparison of several of the prominent makes of compressors. Also editorial. 1400 w. Compressed Air—April, 1902. No. 47480.

Conveyors.

Coal and Ash Conveying Gear. R. A. Chattock. Describes conveying apparatus most in use, pointing out their advantages and defects. 3000 w. Ir & Coal Trds Rev—March 28, 1902. No. 47443 A.

Gears.

Spiral Gear Designing Relieved of Uncertainty and Tedium. W. H. Croker. Aiming to show that a little geometrical construction is all that is needed to secure a reliable solution of any case. 1500 w. Am Mach—April 10, 1902. No. 47485.

Wheel Gearing. W. H. Thornbery. Read before the South Staffordshire Iron & Steel Inst. Begins an illustrated discussion of toothed wheels, the general principles governing the shapes and proportions of the various parts, &c. 3000 w. Ir & Coal Trds Rev—April 18, 1902. Serial. 1st part. No. 47696 A.

High Speeds.

High Speed for Shafting and Belting. Charles A. Hague. Describes a large system of transmission, where unusually high belt speeds are employed. 2400 w. Eng Rec—April 19, 1902. No. 47609.

Power Economy.

Power and Its Economical Transmission. Henry Souther. Lecture before the Canadian Mfrs Assn. Considers sources of power, distribution, transmission, losses belts and ropes, shafting and hangers in this issue. 4000 w. Brick—April, 1902. Serial. 1st part. No. 47373.

Shaft Couplings.

Universal or Flexible Joint Couplings. An illustrated article considering the principles, construction and limitations. 3000 w. Mach N Y—April, 1902. No. 47424.

Variable Speed.

A New Variable Speed Transmission. From *La Nature*. Illustrates and describes a device invented by Roger de Montais.

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1500 w. Sci Am—April 19, 1902. No. 47558.

Wire Ropes.

Wire Ropes. Abstract of a paper by W. D. L. Hardie. Describes the construction of wire ropes for mine use, and its various grades, giving required tests. 1700 w. Can Engr—April, 1902. No. 47372.

SPECIAL MOTORS.

Gas Engine.

Engine for Blast Furnace Gases (Hochofengasmotor). Illustrated description of the improved double-cylinder gas engine of 350 h. p. made by Soest, of Reisholz, near Düsseldorf, for use with furnace gas. 1800 w. 1 plate. Stahl u Eisen—April 15, 1902. No. 47741 D.

Gas Engines. George F. Macmun, Jr. Read before the New England Assn. of Gas Engrs. A narration of experiences and observations, difficulties encountered and methods of overcoming them. 2500 w. Am Gas Lgt Jour—March 31, 1902. No. 47244.

Horse Power in Gas Engines. Albert Stritmatter. Discusses the things that affect the power of an engine. 1700 w. Am Mfr—April 10, 1902. No. 47467.

Large Gas Engines for Driving Electric Generators. A. R. Bellamy. Abstract of a paper read before the Manchester section of the Inst. of Elec. Engrs. Summarizes the complaints that have been brought against the gas engine, explaining what has been done to obviate them. 3800 w. Mech Engr—April 12, 1902. No. 47582 A.

The Cockerill Variable Cut Off Gear for Gas Engines. Illustrated detailed description. 1200 w. Ir Age—April 24, 1902. No. 47640.

The Niel Gas Engine (Nouveau Moteur à Explosion de la Campagnie des Moteurs Niel). The improved Niel engine has the regulation effected by the use of a variable compression. A thermal efficiency of 25 per cent, is attained. 1200 w. 1 plate. Génie Civil—March 29, 1902. No. 47704 D.

The Reid Gas Engine. Illustrations and particulars of an engine used for pumping at the oil wells in Pennsylvania. 1700 w. Am Mach—April 17, 1902. No. 47548.

STEAM ENGINEERING.

Angular Velocity.

The Angular Speed Variations of Crank Engines (Ungleichformig-keitsgrad und Winkelabweichung bei Kurbel Kraftmaschinen). F. Klönne. A mathematical investigation of the angular variations of steam and gas engines, when used for driving electric generators. 5000 w. Elektrotech Zeitschr—April 3, 1902. No. 47749 B.

Boilers.

A Water-Tube Locomotive Boiler. Illustrated description of a type used on the London & Southwestern Railway, England. 500 w. Ry Age—March 28, 1902. No. 47242.

Boiler Corrosion. H. C. Lincoln. Discusses the causes, the feed water supply, incrustation and its prevention. &c. 2200 w. Am Elect'n—April, 1902. No. 47380.

Boiler Repairs. W. J. Ranton. Considers the different types of boilers and the repairs generally needed. Ill. 2000 w. Power—April, 1902. No. 47492 C.

Boiler Testing. Charles L. Hubbard. A brief description of how to carry on a test and make the necessary computations. 2600 w. Am Elect'n—April, 1902. No. 47379.

Circulation in Water-Tube Boilers. A. C. Elliott. Investigations of the Belleville boiler, with explanation of method. 4000 w. Engng—April 18, 1902. No. 47688 A.

Circulation in Water-Tube Boilers. William H. Booth. A practical explanation of the principles and action. 3800 w. Elec Rev, Lond—April 4, 1902. No. 47523 A.

Distortion in Boilers Due to Overheating. C. E. Stromeyer. Paper read before the Inst. of Naval Archts., with discussion. Considers the nature and difficulties of the problem and suggests possible cause. 9800 w. Engng—April 4, 1902. No. 47519 A.

The Oil-Burning Water-Tube Locomotive Boiler. Brief illustrated description of a design used on the Northern Pacific Railroad. 600 w. Sci Am—March 29, 1902. No. 47225.

Chimneys.

See Civil Engineering, Construction.

Condensers.

Condensing Engine Practice. Alex. Dow. An illustrated description of the Edwards pump, and reference to other points in condenser practice. 3300 w. Jour Assn of Engng Socs—March, 1902. No. 47620 C.

Experience with Central Condensers in Mine Power Plants (Versuche und Beobachtungen an Central-Kondensationen auf Steinkohlenzechen). E. Stach. A very complete series of trials, showing the advantages of condensation, and the conditions under which the best results may be attained. 5000 w. 3 plates. Glückauf—March 29, 1902. No. 47764 B.

Separation of Oil from Condensed Steam. J. R. Bibbins. A detailed account of experimental work to evolve a method of freeing engine condensation of entrained oil. Ill. 6200 w. Jour Assn of Engng Socs—March, 1902. No. 47619 C.

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Engines.

High-Speed Engines. Discusses the merits and advantages of high rotary speeds, and the troubles. 1500 w. Engr, Lond—April 4, 1902. No. 47515 A.

The Ferranti Vertical Compound Engine. Abstract of paper by Mr. Charles Day, presented to the Manchester (England) Assn. of Engrs. Illustrates and describes the type of engine which the firm is building for use with large direct-connected electrical units. 4200 w. Power—April, 1902. No. 47489 C.

Vertical High-Speed Engines Abroad. Frank C. Perkins. Illustrated descriptions of power plants containing installations of some of the leading foreign builders. 2500 w. Steam Engng—April, 1902. No. 47624.

Evaporation.

The Transmission of Heat in the Evaporation of Water (Die Wärmeübertragung bei der Verdampfung von Wasser). Dr. H. Claassen. Giving data and results of experiments for the determination of the rate of heat transmission, with especial reference to evaporating kettles and vacuum pans. 7000 w. Zeitschr d ver Deutscher Ing—March 22, 1902. No. 47709 D.

Explosion

The Investigation of the Penberthy Boiler Explosion. Prof. R. C. Carpenter. Report of the explosion in Detroit which killed 30 people and seriously injured many more. Ill. 4400 w. Power—April, 1902. No. 47494 C.

Furnace Equipment.

The Scott-Elliot Furnace Equipment for Steam Boilers. Illustrates and describes a simple apparatus with which, it is claimed, that a considerable saving in fuel has been obtained. Gives report of trials. 2000 w. Engng—April 11, 1902. No. 47600 A.

Governors.

The Regulating of High-Speed Engines by Shaft Governors (Beitrag zur Frage der Regelung Schnellaufender Dampfmaschinen durch Achsenregler). J. Finkel. Showing the application of the shaft governor to valves of the Corliss and the piston types, with details of recent German governors. 2500 w. Zeitschr d ver Deutscher Ing—March 15, 1902. No. 47706 D.

Mechanical Plant.

The Mechanical Plant of the Broad Exchange Building. Illustrated description of the plant for operating 18 passenger elevators and a steam and electric plant of proportionate capacity in a building having over 11 acres of floor space. 2300 w. Eng Rec—April 19, 1902. No. 47615.

The Mechanical Plant of the Collingwood Apartment Hotel, New York. Illustrated description of the plant in a 12-story apartment hotel for electric lighting, refrigerating, heating and ventilating services. 2100 w. Eng Rec—April 5, 1902. No. 47326.

The Mechanical and Heating Apparatus in the New Century Apartment House, New York. Illustrated description of the mechanical plant for an electric lighting, refrigerating, elevator service, laundry and heating system in a 9-story apartment house 96-ft. square. 1500 w. Eng Rec—April 12, 1902. No. 47479.

Metallic Packings.

Metallic Packings for Piston and Valve Rods. C. G. Robbins. Describes and illustrates a number of the prominent packings, pointing out the special features and showing the application. 7800 w. Power—April, 1902. No. 47493 C.

Pipes.

Thickness of Pipes. William Burlingham. Gives diagrams embodying the formulæ for the thickness of steam and feed pipes for marine work. The method shown is of general application and saves much time. 1800 w. Marine Engng—April, 1902. No. 47269 C.

Piping.

Feed Water Piping. C. G. Robbins. Illustrates and describes many of the arrangements. 1500 w. Power—April, 1902. No. 47490 C.

Safety Valves.

Safety Valves (Soupapes de Suréte). F. Sinigaglia. An exhaustive discussion of the design and proportions of safety valves for steam boilers, with data as to discharge, and an examination of the various formulas. Serial, Part I. 5000 w. Revue de Mécanique—March 31, 1902. No. 47729 E + F.

Scale.

Boiler Scale Solvents. D. B. Dixon. On the best means to prevent incrustations and other points relating to the care of boilers. 2000 w. Am Mfr—April 10, 1902. No. 47466.

Slide Valve.

A New High Pressure Balanced Slide Valve. Illustrates and describes a valve designed to work easily under pressures as great as 250 lbs. 1000 w. Am Engr & R R Jour—April, 1902. No. 47346 C.

Speed Regulation.

Discussion on Speed Regulation of Prime Movers. Discussion at New York, Oct. 25, 1901, of papers on this subject read before the Society. 10600 w. Trans Am Inst of Elec Engrs—March, 1902. No. 47576 D.

Steam Economy.

Effect of Cylinder Clearance Upon Steam Economy. Ira C. Hubbell. Dis-

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cusses some interesting practical experiments made during the last two years. 1800 w. St. Louis Ry Club—March 14, 1902. No. 47232.

Valves.

Piston, Corliss and Double-Beat Valves. A comparison with discussion of the merits of these types, and illustrated description of the Van den Kerchove gear. 900 w. Am Elect'n—April, 1902. No. 47376.

MISCELLANY.

Aeronautics.

A New Air Ship. Illustrated description of the Barton air ship now being built, and of the principles on which it is based. 1500 w. Engr, Lond—April 18, 1902. No. 47694 A.

The Crossing of the Sahara (A Propos de la Traversée du Sahara). Leo Dex. An examination of the practicability of crossing the desert of Sahara by a balloon controlled by a guide rope and propelled by wind only. 2000 w. Revue Technique—March 25, 1902. No. 47705 D.

The Severo Airship. Illustrated description of an interesting airship being constructed in Paris, which is quite novel in design. 1100 w. Sci Am—March 29, 1902. No. 47227.

Alcohol.

Lighting and Heating by Alcohol (L'Eclairage et le Chauffage par l'Alcool) L. Lindel. A discussion of the conference of the Société d'Encouragement, with tabulated results of the consumption of alcohol in lighting and heating. 3000 w. Rev Gen des Sciences—March 30, 1902. No. 47761 D.

Basket-Making.

The Mergenthaler-Horton Basket-Making Machinery. Illustrates and describes a machine for making fruit baskets which accomplishes in an hour more than is possible for 12 skilled basket makers, and at a cost less than the wages of a single workman. A description of the three types of machines now in use. 1700 w. Sci Am—March 15, 1902. No. 46810.

British Patents.

The Government Patent Bill. Editorial discussion of proposed patent law reform in England. 2800 w. Engng—Feb. 28, 1902. No. 46727 A.

Calculating Machine.

The Mechanical Work of the Twelfth Census. Edward M. Byrn. Illustrates and describes the Hollerith system of mechanical punching and tabulation in its latest development. 1900 w. Sci Am—April 19, 1902. No. 47559.

Calorimetry.

On the Calorimetric Properties of the Ferro-Magnetic Substances. Bruce V. Hill. A report of experimental investigations. 2000 w. Elec Rev, N. Y—March 29, 1902. No. 47234.

Carbonic Acid.

The Preparation and Applications of Liquid Carbonic Acid (La Preparation Industrielle et les Applications de l'Acide Carbonique Liquide). E. Mathias. Describing the modern methods of preparing the liquefied gas, and its numerous uses in the arts. Two articles. 7500 w. Rev Gen des Sciences—Feb. 28, March 15, 1902. No. 47760 each D.

Graphics.

Graphic Integration—Area, Center of Gravity, Moment of Inertia, &c. Karl G. Holst. Gives an approximate method of drawing an integral curve. 1400 w. Am Mach—April 10, 1902. No. 47486.

Heating.

Modern Furnace Heating. A combination of hot air and hot water heating and ventilating system is illustrated and described. 3000 w. Met Work—April 5, 1902. No. 47357.

Physical Laboratory.

The National Physical Laboratory. An illustrated article describing this recently opened laboratory in England, and its equipment. 5000 w. Elec Engr, Lond—March 21, 1902. No. 47284 A.

Refrigeration.

Improved Refrigerating Appliances in Breweries (Neuere Kühlanlagen in Brauerlien). R. Schöttler. Illustrating and describing the installations of the Linde refrigerating apparatus in a number of German breweries. 2500 w. 2 plates. Zeitschr d Ver Deutscher Ing—April 5, 1902. No. 47713 D.

Thermal Properties.

Some Thermal Properties of Naphthas and Kerosenes. A. H. Gill and H. R. Healey. Experimental work to determine the heating value is described. 2000 w. Tech Qr—March, 1902. No. 47817 E.

Ventilation.

Ventilating and Heating St. Bartholomew's Clinic, New York City. Illustrated description of an installation with ventilating apparatus independent of the heating system and supplying 6000 cu. ft. of air per hour per capita in many rooms; heating by direct radiators supported on hangers to facilitate cleaning the floors; and fitted with special cleaning apparatus for the air filters. 2500 w. Eng Rec—March 29, 1902. No. 47207.

Ventilating and Heating the Eastern High School, Detroit, Mich. Illustrated description of a 224 x 220-ft. building having an independent electric plant and a forced circulation of heated air for warming the main rooms. 1500 w. Eng Rec—April 26, 1902. No. 47649.

We supply copies of these articles. See page 487.

MINING AND METALLURGY

COAL AND COKE.

Arsenic.

Arsenic in Coal and Coke. Alfred C. Chapman, in *The Analyst.* Describes the method adopted by the writer for the detection and estimation of arsenic. The method consists in the gentle ignition of the fuel with a mixture of magnesia and carbonate of soda. 1500 w. Ir & Coal Trds Rev—April 4, 1902. No. 47522 A.

British Columbia.

The Crow's Nest Pass Coal-Fields. William M. Brewer. Gives the history and geology, with description of these deposits in the southeast part of British Columbia. 4000 w. Eng & Min Jour—April 19, 1902. No. 47634.

By-Products.

The Production of Sulphate of Ammonia from Coke Oven Wastes (Zur Herstellung von Schwefelswirem Ammoniak auf den Destillations-Kokereien). A discussion of the value of coke oven wastes, and the manner in which they can be utilized. 2000 w. Glückauf—March 15, 1902. No. 47762 B.

Coal Fields.

The Rocky Mountain Coal Fields. Concerning the extent, location, quality, and production of the fields now worked. 2400 w. Sci Am Sup—April 5, 1902. No. 47387.

Coal Supplies.

See Industrial Economy.

Coke Ovens.

Recent Developments in By-Product Coke Ovens. Communications from Dr. F. Schniewind, Thomas Littlehales, and C. W. Andrews, to the Ohio Gas Lgt. Assn., with discussion. 9500 w. Am Gas Lgt Jour—April 28, 1902. No. 47685.

Floods.

Some Lessons from the Recent Floods in the Anthracite Mines of Pennsylvania. W. S. Ayres. Discusses the serious results and great expense caused by the floods of this past winter, and the means of guarding against such loss. 1700 w. Eng & Min Jour—March 15, 1902. No. 46823.

Germany.

The Government Acquisition of Westphalian Coal Mines. Discusses the recent purchase of this coal-mining property by the German government, comparing the present situation with that prevailing two or three months ago. 2000 w. Col Guard—Feb. 28, 1902. No. 46725 A.

Pacific Coast.

The Coal Resources of the Pacific. Harrington Emerson. A fully illustrated description of the various available sources of coal supply on the Pacific ocean, emphasising especially the central position and splendid quality of the Alaskan coals. 4000 w. Engineering Magazine—May, 1902. No. 47771 B.

Peat.

Peat Fuel in Scandinavia. Alfred Bache. Summary of recent articles on peat fuel published in leading Scandinavian periodicals. Deals with the Swedish, Norwegian and Danish countries separately. 2800 w. Col Guard—April 4, 1902. Serial, 1st part. No. 47520 A.

Russia.

The Coal-Mining Industry of Russia. Particulars, prepared by A. Loransky, extracted from a recently published work issued by order of the State Secretary. 2400 w. Col Guard—March 27, 1902. Serial, 1st part. No. 47446 A.

Safety Appliances.

Preventing Shock to the Cage on Reaching the Pit Bottom. From *Glückauf.* Illustrates and describes a device recently invented by J. Römer, explaining its action. 600 w. Col Guard—March 27, 1902. No. 47445 A.

COPPER.

Australia.

Australian Copper Production. Concerning the production and development of the copper mines. 1500 w. Engng—April 11, 1902. No. 47509 A.

Boundary District.

Metallurgical Progress in the Boundary District. W. A. Harkin. Describes the Granby Works, the largest copper smelting works in Canada. 2500 w. B C Min Rec—April, 1902. No. 47481 B.

Concentration.

Electro-Magnetic Concentration. V. F. Stanley Low. Its employment in the treatment of copper ores is discussed. 1000 w. Aust Min Stand—Feb. 27, 1902. No. 47436 B.

Reduction.

The Reduction of Copper by Solutions of Ferrous Salts. H. C. Biddle. Abstracted from *American Chemical Journal.* Describes the method of reduction. 1500 w. Min Rept—April 17, 1902. No. 47625.

Sampling.

An Automatic System of Sampling. Paul Johnson. Detailed descriptions with

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illustrations, of the practice at the British Columbia Copper Companies Smelting Works. 2500 w. Eng & Min Jour—April 12, 1902. No. 47502.

South America.

South American Copper. Information concerning the production of the various countries, and the undeveloped properties, with report of fuel conditions. 1800 w. Am Mfr—March 27, 1902. No. 47263.

Wolverine Mine.

The Wolverine Copper Mine. F. J. Nicholas. Brief account of this mine, opened in 1882, but not really worked until 1889. 1000 w. Eng & Min Jour—April 26, 1902. No. 47663.

GOLD AND SILVER.

Alaska.

Investigation of the Mineral Resources of Alaska. Map with brief account of work being done by the Geological Survey. 700 w. Eng & Min Jour—April 26, 1902. No. 47664.

Arizona.

The Geology of the Galiuro Mountains, Arizona, and of the Gold-Bearing Ledge known as Gold Mountain. William P. Blake. An illustrated description of the ledge and deposits. 2400 w. Eng & Min Jour—April 19, 1902. No. 47633.

Brazil.

Historical Sketch of Gold Mining in Minas Geraes, Brazil. Alcides Medrado. Brief account of this rich gold field, and its production. 1100 w. Eng & Min Jour—March 29, 1902. No. 47238.

Bromo- Cyanogen.

Experiments with Bromo-Cyanogen on Southern Gold Ores. S. H. Brockunier. Results of experiments made to find a more economical method of extraction than chlorination. 1500 w. Trans Am Inst of Min Engrs—Nov., 1901. No. 47542 C.

Cyanide.

Cyaniding in the Telluride District. J. Ralston Bell. An illustrated description of the plant and practice at the Liberty Bell mine. 1800 w. Mines & Min—April, 1902. No. 47330 C.

Notes on the Cyanide Process. J. P. Empson. Abstracts from a paper read before the Black Hills Mining Men's Assn. Reviews the early history of this process, describing the practice in New Zealand and Australia. 1600 w. Min Rept—March 27, 1902. No. 47261.

The Manufacture of Cyanides. Editorial discussing the preparation of cyanides, with remarks on the present position and greatly-extended application. 1500 w. Engng—March 21, 1902. No. 47294 A.

East Indies

Mining in the Dutch East Indies. S. J. Truscott. The gold mining in Sumatra and Borneo is reported in this first article, with related matter of interest. 3200 w. Aust Min Stand—Feb. 20, 1902. Serial, 1st part. No. 47434 B.

Placers.

Placer Mining Kinks. Charles P. Richardson. Illustrates and describes simple devices made where materials were scarce and hard to obtain. 2300 w. Min & Sci Pr—March 29, 1902. Serial, 1st part. No. 47363.

Queensland.

The Saddle Reefs of Bendigo. T. A. Rickard. An illustrated historical account of this rich gold field which has produced a yield valued at $342,000,000, describing various types of the saddle reefs. 5000 w. Eng & Min Jour—March 29, 1902. No. 47236.

Rand.

The Easterly Extension of the Rand Goldfields. From the London *Mining Journal.* An account of prospecting and the difficulties met. 4000 w. N Z Mines Rec—Feb. 17, 1902. No. 47428 B.

Tailings.

The Tailings Cyanide Plant of the Homestake Mine, South Dakota. Charles H. Fulton. Abstract from Bulletin No. 5, South Dakota School of Mines. Describes a plant which satisfactorily treats the tailings pulp of three mills. The company does not print the disclosure of information concerning the technical working of their plant. Ill. 1200 w. Min Rept—March 13, 1902. No. 46877.

West Australia.

The West Australia Gold Fields. Arthur Howell. Discusses their progress and prospects, Coolgardie and Kalgoorlie, and the activity on the "Northern Fields." 3800 w. Mines & Min—April, 1902. No. 47333 C.

IRON AND STEEL.

Analysis.

An Accurate Estimation of Sulphur in Iron by the Evolution Method. Harry E. Walters and Robert Miller. An explanation of methods, with report of results. 1000 w. Pro Engrs Soc of W Penna—March, 1902. No. 47312 D.

Blast Furnaces.

An Improved Method of Supplying Water to Blast Furnace Tuyeres and Coolers. W. J. Foster. Illustrates and describes a method that has been in use more than twelve months with very satisfactory results. 2200 w. Ir & Coal Trds Rev—April 11, 1902. No. 47592 A.

Blast Furnace with Electric Power Plant at Audun-le-Tiche, Lorraine. Frank

We supply copies of these articles. See page 487.

C. Perkins. Illustrated detailed description. 1000 w. Am Mach—April 17, 1902. No. 47547.

Electric Lifts for Furnace Bell-Tops. F. Janssen, in *Stahl und Eisen*. Illustrates and describes a bell-top lift that has been in operation for about a year, and considers the advantages derived from the use of electricity for working the bell-top. 2000 w. Am Mfr—April 3, 1902. No. 47359.

The Elimination of Blast Furnace Variables. F. L. Grammer. Some conclusions in regard to the management of blast furnaces. 3000 w. Ir Trd Rev—April 10, 1902. No. 47483.

The Rader Blast Furnace. Illustrates the construction of a recently patented furnace. 900 w. Am Mfr—April 17, 1902. No. 47622.

Cast Iron.

The Testing and Classification of Pig Iron and Castings (Zur Frage der Prufung, Beurtheilung und Ein theilung von Giessereiroheisen und Gusseisen). B. Osann. A review of the standard specifications of the American Foundrymens Association, with comments. 3000 w. Stahl und Eisen—March 15, 1902. No. 47733 D.

Crucibles.

Clays and Clay Crucibles. Percy Longmuir. Concerning the composition of crucibles, the apparatus required for making them, their life, &c. 2000 w. Ir Trd Rev —April 3, 1902. No. 47400.

Hematite.

Geological History of the Hematite Iron Ores of the Antwerp and Fowler Belt in New York. W. O. Crosby. 2800 w. Am Geol—April, 1902. No. 47442 D.

Hot Blast.

Hot Blast Stoves (Ueber Winderhitzer). G. Teichgräber. A discussion of recent designs for stoves for heating the wind for blast furnaces, with especial reference to the improvement in the combustion of the gases. 1800 w. Stahl u Eisen —March 15, 1902. No. 47734 D.

Iron Industry.

A Bird's-Eye View of Conditions in the Iron and Steel Industry. Editorial review of the present situation as presented in the recently issued "Directory of the Iron and Steel Works of the United States," and a comparison with the situation four years ago. 1800 w. Eng News—March 27, 1902. No. 47255.

The Recent Development of the American Iron Industry (Die Neuere Entwicklung der Nordamerikanischen Eisenindustrie). E. Schrödter. A comparison of the iron industries of Great Britain, Germany, France, Austria, and Russia, with the United States, showing the rapid growth of the latter. 3000 w. Stahl u Eisen—March 15, 1902. No. 47732 D.

Iron Works.

The Iron Mountain, and the Plant of the Mexican National Iron and Steel Company, Durango, Mexico. F. F. Witherbee. Gives view of mountain and works, with description of ore, method of working, &c. 1800 w. Trans Am Inst of Min Engrs—Nov., 1901. No. 47543 C.

Krupp Works.

Some Interesting Features of the Krupp Works at Essen. Henry L. Geissel. An illustrated article giving particulars of interest and showing the immense extent of the works. 1500 w. Sci Am—April 19, 1902. No. 47561.

Minnesota.

Sketch of the Iron Ores of Minnesota. N. H. Winchell. An account of explorations, production, geological relations, origin of the ores, &c. 2200 w. Am Geol—March, 1902. No. 47431 D.

Mixers.

A 325-Ton Hot-Metal Mixer. Arthur C. Johnston. Illustrates and describes the chief features of a very successful vessel of this capacity. 900 w. Eng News—April 3, 1902. No. 47457.

Modern Pig Iron Mixers (Neuere Roheisenmischer). J. Nockher. Illustrating and describing various forms of mixers used in Luxembourg and Westphalia. 1800 w. Zeitschr d Ver Deutscher Ing—March 22, 1902. No. 47710 D.

Rails.

Microscopic Observations in Deterioration in Steel Rails. Thomas Andrews. Observations on the micro-crystalline structure, chemical and physical properties, of a Bessemer steel rail, unbroken after fifteen years' main line service. 2500 w. Engng—April 18, 1902. No. 47689 A.

Rolling Mill.

Rolling Mill for Billets (Blockwalzwerk). W. Schnell. Illustrated description of rolling mill and double reversing tandem reversing engines at the Röchling iron works at Völklingen on the Saar. 1000 w. 3 plates. Stahl u Eisen—April 15, 1902. No. 47740 D.

Slags.

A Study of Slags (Zur Kenntniss der Schlacken). H. v. Jüptner. A chemical study of the furnace slags and their relation to the metallic products. Two articles. 1 plate. Oesterr Zeitschr f Berg u Hüttenwesen—March 29, April 5, 1902. No. 47768 each B.

Steel.

New Methods in Steel Manufacture. Briefly outlines methods for the production of compound ingots, to shorten time in open-hearth process, and hydrogen treatment of Bessemer and open-hearth

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steel. 3000 w. Ir Trd Rev—March 27, 1902. No. 47210.

Steel Plant.

Plant of the Dominion Iron and Steel Company. Waldon Fawcett. Description of a new Canadian plant at Sydney, Cape Breton. 2000 w. Am Mfr—March 13, 1902. No. 46817.

Some of the New and Enlarged Bridge and Structural Mills. Brief report of proposed extensions and new plants. 1700 w. R R Gaz—March 14, 1902. No. 46828.

Steel Treatment.

The Correct Treatment of Steel. Read before the Glasgow Congress. The object of the paper is to help those who handle steel by describing in simple, practical terms such fixed principles as are known, and in what direction they may be applied in practice, and to obtain discussion on important points. 1300 w. Jour Am Soc of Naval Engrs—Feb., 1902. No. 47051H.

Steel Rails.

The Manufacture of Steel Rails. Brief illustrated description of the Edgar Thomson Works, near Pittsburg. 1600 w. Sci Am—April 26, 1902. No. 47658.

Sulphur.

The Sulphur Content of Slag and Other Furnace Products (Der Schwefelgehalt von Schlacken und Hüttenproducten). H. von Jüptner. An examination of the distribution of sulphur in slag and metal in connection with the solution theory. Two articles, 4000 w. Stahl u Eisen—April 1, 15, 1902. No. 47739 each D.

Texas.

The Iron Resources of Texas. Dr. William B. Phillips. Considers the iron resources in a general way and states conclusions. 6500 w. Pro Engrs' Soc of W Penna—March, 1902. No. 47311 D.

MINING.

Auditing.

The Auditing of a Mining Company's Accounts. Charles V. Jenkins. On the value of an audit, inspection of accounts by mining engineers, the conduct of an audit, redemption of capital, etc. 5700 w. Trans Am Inst of Min Engrs—Feb., 1902. No. 47540 D.

China.

Mining in China. Information in regard to the working methods, labor and wages, etc. 1200 w. U S Cons Repts, No. 1319—April 18, 1902. No. 47564 D.

Colorado.

Geology Along the Animas River, with Description of Coal and Metal Mines Along Its Course, Including a Sketch of the Silver Lake Mine. Arthur Lakes. Ill. 2200 w. Mines & Min—April, 1902. No. 47334 C.

Deposits.

Ore Deposits. F. Danvers-Power. Read at meeting of the N. S. W. Chamber of Mines. A general talk on the world's debt to the mineral kingdom and geology, followed by a review of accepted opinions on the origin of ores, their deposition, etc. 6500 w. N Z Mines Rec—Feb. 17, 1902. No. 47429 B.

Firedamp.

Determination of Fire Damp by the Limits of Inflammability. J. Potier, in *Revue Universelle des Mines.* Describes a modification of the Lebreton and Rateau methods, giving drawing of apparatus. 800 w. Col Guard—March 27, 1902. No. 47447 A.

Geology.

Why Employ a Geologist? Arthur Lakes. Gives cases in which a knowledge of geology is necessary to successfully prospect for oil or ores. 1000 w. Mines & Min—April, 1902. No. 47335 C.

Haulage.

See Electrical Engineering, Power Applications.

Hole-Contract.

The Operation of the "Hole-Contract" System in the Center Star and War Eagle Mines. Contribution to the discussion of paper by Carl H. Davis. 900 w. Trans Am Inst of Min Engrs—Nov., 1901. No. 47541.

Importance.

The National Importance of Mining. John E. Hardman. An address introducing topic for discussion at the annual meetings of the Canadian Mining Institute. 5000 w. Can Min Rev—March 31, 1902. No. 47270 B.

Mexico.

A Synopsis of the Mining Laws of Mexico. Richard E. Chism. A digest of the more important laws. 19300 w. Trans Am Inst of Min Engrs—Nov., 1901. No. 47537 D.

Mine Fires.

Mine Fires in Pittsburg Region. James Blick. Read before the Cent. Min. Inst. of W. Penn. Gives their history and causes and methods used to subdue them, as gleaned from observation. 4600 w. Mines & Min—April, 1902. No. 47332 C.

Mine Pump.

Underground Mine Pump of 1000 Horse Power (Unterirdische Wasserhaltungsmaschine von 1000 PS.) S. Steuer. Description of powerful mining pump installed in the Czeladz mine at Sosnowice, in Russian Poland. 1000 w. 1 plate. Zeitschr d ver Deutscher Ing—March 29, 1902. No. 47711 D.

Mining Law.

The Colorado Central Lode a Paradox

of the Mining Law. Ernest Le Neve Foster. Read before the Colorado Sci. Soc. Begins an account of the litigation over this mine. 1200 w. Min Rept—April 24, 1902. Serial. 1st part. No. 47813.

Mining Plant.

See Electrical Engineering, Power Applications.

Mining Tunnel.

Driving the Newhouse Tunnel. H. Foster Bain. An illustrated description of one of the most interesting mining tunnels in existence, now being driven at Idaho Springs, Colorado. 2200 w. Eng & Min Jour—April 19, 1902. No. 47635.

The Newhouse Tunnel. A. W. Warwick. An illustrated account of one of the greatest tunnel schemes ever undertaken, now being carried out at Idaho Springs, Colorado. 2800 w. Min Rept—April 24, 1902. No. 47812.

Oil Field.

The Western Oil Field of Mesa and Rio Blanco Counties, Colorado. Arthur Lakes. Illustrates and describes a region geologically favorable for oil. 2200 w. Mines & Min—April, 1902. No. 47331 C.

Plumb Lines.

The Divergence of Long Plumb Lines at the Tamarack Mine. Prof. F. W. McNair. An account of experiments made in the shafts of this mine, and a discussion of the cause of divergence. Ill. 3000 w. Eng & Min Jour—April 26, 1902. No. 47662.

Shaft Sinking.

Improvements in Apparatus for Shaft-Sinking. A. Gobert. From *Annales des Travaux Publics de Belgique*. Drawings and description of improvements to remedy the inconveniences arising from defective circulation. 800 w. Col Guard—March 21, 1902. No. 47305 A.

Sinking and Installing a Shaft, 1,010 Metres in Depth, at the Ronchamp Collieries. From *L'Ingénieur Français*. Illustrates and describes the ventilation, sinking, winding engine, central engine house, air compressors and boilers. 2500 w. Col Guard—March 27, 1902. No. 47444 A.

Small Ores.

The Utilization of Small Ores. H. Bumby. Read before the West of Scotland Iron & Steel Inst. Concerning the briquetting of such ores and the processes. 4000 w. Ir & Coal Trds Rev—March 21, 1902. No. 47300 A.

Smelting.

Smelting Arsenical Ores in Blast Furnaces. Herbert Lang. Outlines the method of treatment and reports the success. 2300 w. Min & Sci Pr—March 29, 1902. No. 47362.

Training.

The Training of Mining Engineers. H. C. Jenkins. Read before the Australian Assn. for the Adv. of Science. Discusses what the engineer manager should be if fully equipped for his work. 3200 w. Aust Min Stand—Feb. 27, 1902. No. 47435 B.

Tributing.

Tributing in Mining. Jas. Grant. The present article consists of introductory remarks on the general subject of tributing. 2300 w. Aust Min Stand—March 6, 13, 1902. Serial. 2 parts. No. 47643 each B.

Winding Engine.

Non-Condensing Double-Drum Winding Engine. Illustration and brief description of engine made for the Associated Gold Mines of Western Australia, Limited. 600 w. Engng—April 18, 1902. No. 47690A.

Wire Ropes.

Some Notes on Wire Ropes. G. W. N. Hopper. Discusses points relating to the use of wire ropes in colliery practice. 1700 w. Ir & Coal Trds Rev—March 21, 1902. No. 47298 A.

MISCELLANY.

Alloys.

Metallic Alloys. J. E. Stead. Considers the constituents of alloys, the methods employed for studying the constitution and properties of alloys, classification of binary alloys, and alloy charts for representing the structural, constitutional and physical properties of alloys. Ill. 9000 w. Metallographist—April, 1902. No. 47566 E.

The Freezing-Point Curve of Binary Alloys of Limited Reciprocal Solubility When Molten. H. M. Howe. Tests of curves showing that the very convenience of these graphical illustrations may cause them to mislead. 2000 w. Metallographist—April, 1902. No. 47567 E.

Aluminum.

Aluminum Properties and Reactions. From the French of M. J. Cavalier. A review of recent researches and their interesting results. 2500 w. Am Mfr—April 17, 1902. No. 47623.

Furnace.

An Adobe Reverberatory Furnace. John Gross. Describes briefly the construction of a furnace which is giving good results and can be quickly erected. Ill. 900 w. Trans Am Inst of Min Engrs—Nov., 1901. No. 47544 C.

Lead.

The Disseminated Lead Ores of South East Missouri. Frank L. Nason. Facts in regard to the occurrences of lead ores in this section, their origin and peculiarities. 3000 w. Eng & Min Jour—April 5, 1902. No. 47405.

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Metals.

The Crystalline Structure of Metals. J. A. Ewing and Walter Rosenhain. Describes investigations dealing principally with the phenomena of annealing. Ill. 9000 w. Metallographist—April, 1902. No. 47565 E.

Ozark Region.

Lead and Zinc Deposits of the Ozark Region. Information of the ore-bearing formations and mining districts of this region, giving theories of ore deposition, their origin, conditions, etc. 2700 w. Eng & Min Jour—April 5, 1902. No. 47403.

Petroleum.

The Boulder Oil Fields. Information concerning this field in Colorado, which is at present causing much excitement 1000 w. Eng & Min Jour—March 29, 1902. No. 47237.

The Russian Petroleum Trade. Information concerning the production of crude oil of the Baku fields, causes of depression, refining, residuum, transportation, etc. Map. 11900 w. U S Cons Repts, No. 1312—April 10, 1902. No. 47441D.

The Petroleum District of Northwestern Germany (Das Erdösvorkommen in Nordwestlichen Deutschland). P. H. Sachse. An account of the wells and product, showing the growing importance of the district. 2000 w. Glückauf—April 5, 1902. No. 47765 B.

Platinum.

Notes on Platinum and Its Associated Metals. James F. Kemp. Describes its occurrence, where found, its association with other minerals, etc. 2000 w. Eng & Min Jour—April 12, 1902. No. 47501.

Platinum and the Platinum Metals. Dr. J. Ohly. Discusses the commercial importance of platinum and begins a review of its history in the present article. 1200 w. Min Rept—March 27, 1902. Serial. 1st part. No. 47262.

Sulphur Deposits.

The Sulphur Deposits of Calcadieu Parish. Frank M. Kerr. Concerning these deposits in Louisiana and their development; methods, and their results, etc. 2800 w. Jour Assn of Engng Socs—Feb., 1902. No. 47214 C.

Titanium.

Titanium Iron (Ueber Titaneisen). E. Bahlsen. An examination of the influence of titanium upon iron and the use of ferro-titanium in the manufacture of special steels. 1800 w. Stahl u Eisen—March 15, 1902. No. 47735 D.

Zinc.

American Zinc Production. Waldon Fawcett. Deals principally with the Joplin district, giving information concerning the gains in production, methods, etc. Ill. 1600 w. Am Mfr—April 24, 1902. No. 47656.

Palmerton Plant of the New Jersey Zinc Company (of Pennsylvania). George C. Stone. Description of these works and their location. 2500 w. Eng & Min Jour—April 5, 1902. No. 47406.

The Production of Zinc Ore in the United States. Walter Renton Ingalls. Reports the production of the various districts, giving information of interest relating to them. Ill. 3300 w. Eng & Min Jour—April 5, 1902. No. 47404.

RAILWAY ENGINEERING

CONDUCTING TRANSPORTATION.

Accidents.

Train Accidents in the United States in February. Condensed record of the principal train accidents, with remarks on the most serious. 3600 w. R R Gaz—March 28, 1902. No. 47222.

Curve Resistance.

Curve Resistance Tests at West Alton, Mo. Max H. Wickhorst. Describes tests made with dynamometer car on 7½ degree curve to determine the relative resistance of a train on straight track and curves at this point. 1200 w. Am Engr & R R Jour—April, 1902. No. 47341 C.

Fast Run.

The Fastest Timed Railway Run in Europe. Charles Rous-Marten. Reports a new departure on the Northern Railway of France which gives it the fastest-timed railway run ever yet seen in European time-tables, including the British Isles. 700 w. Engr, Lond—April 18, 1902. No. 47693 A.

Graphic Statistics.

Graphic Statistics of Railways, Showing how the "Revenue Statistics" can be analyzed to exhibit the results of the working clearly and correctly. Deals only with the number of passengers as compared with train mileage but other results can be obtained by the same method. 1500 w. Engr, Lond—March 28, 1902. No. 47452A.

Train.

Train for H. R. H. Prince Henry of Prussia. Illustrated description of the train used during the short tour through the United States. 900 w. Loc Engng—April, 1902. No. 47365 C.

Train Control.

Instruction of Queen and Crescent Train

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Men. A. J. Love, with editorial. The "train staff" system of train control is explained. It makes operating on a single track absolutely free from danger of collisions. 2900 w. Loc Engng—April, 1902. No. 47367 C.

MOTIVE POWER AND EQUIPMENT.

Cars.

A 60,000 Lbs. Capacity Produce Car—New York Central. Illustrations and description showing the design of a 35 ft. produce car, 300 of which are being built for the hauling of fruit and vegetables. 1100 w. R R Gaz—March 28, 1902. No. 47223.

80,000 Lbs. Box Car, Illinois Central R. R. Illustrated description of the latest design of high-capacity box car adopted by this road. 1000 w. Ry & Engng Rev—March 29, 1902. No. 47245.

80,000 Lbs. Capacity Box Car, Norfolk & Western Ry. Illustrated description of the latest type of all-wood box car. 1200 w. Ry & Engng Rev—April 5, 1902. No. 47427.

Forty-ton Steel Frame Box Car, Norfolk & Western Railway. Drawings and description. 1800 w. R R Gaz—April 18, 1902. No. 47654.

Special Milk Cars for the Delaware & Hudson. Illustrates and describes cars used in this service. 600 w. Ry Age—April 11, 1902. No. 47500.

Test of an Ingoldsby 100,000 Lbs. Capacity Wooden Dump Car. Illustration with report of test. 500 w. R R Gaz—April 4, 1902. No. 47392.

36-Ft. Flat Car, Minneapolis, St. Paul S. Ste. Marie Ry. Illustrated description of flat cars of 60,000 lbs. capacity. 800 w. Ry & Engng Rev—April 12, 1902. No. 47507.

Standard 60,000 Lbs. Capacity Box Cars for the Central of New Jersey. Illustrated description. 500 w. R R Gaz—April 11, 1902. No. 47511.

Vanderbilt 50-Ton Hopper Coal Car. Drawings and description of steel hopper cars, designed by Cornelius Vanderbilt, 800 of which are now being built for the West Virginia Central & Pittsburg Ry. 700 w. Am Engr & R R Jour—April, 1902. No. 47338 C.

Car Wheels.

Chilled Cast Iron Car Wheels. C. H. Vannier. Read before the students of Purdue Univ. Describes the method of manufacture in detail. 5000 w. Ir Trd Rev—April 24, 1902. No. 47660.

Draft Gear.

Elasticity in Draft Gear. Extracts from a paper by R. A. Parke, presented at meeting of the Ry. Club of Pittsburg. Discusses the influence of draft gear upon train operation. Gives diagrams taken from the recording apparatus of a dynamometer car arranged to record the compression and recoil strains transmitted through the draft gear. 2300 w. R R Gaz—April 4, 1902. No. 47390.

Elasticity in Draft Gear. R. A. Parke. Presented at meeting of the Ry. Club of Pittsburg. Suggestions presented with a view of considering some of the various demands upon a satisfactory draft-gear and the character of the service rendered. 2200 w. Ry & Engng Rev—April 26, 1902. Serial. 1st part. No. 47815.

Electric Traction.

Electric Traction on Main Lines. Editorial review of paper by E. Huber before the Zurich Assn. of Engrs. & Archts. 1800 w. Engng—April 11, 1902. No. 47508 A.

High Speed.

High Speed Transport with Steam Locomotives (Dampflokomotive und Schnellverkehr). H. Fränkel. A comparison of the performance of express locomotives with the results on the Berlin-Zossen high-speed electric railway. 4000 w. Glasers Annalen—March 15, 1902. No. 47730 D.

Locomotives.

A Discussion of Locomotives (Note sur les Locomotives). E. Sauvage. A general discussion of modern locomotive construction comparing the practice of different countries. Serial. Part 1. 7500 w. Bull Soc d'Encour—March, 1902. No. 47722 G.

A Four-Cylinder Compound for Fast Trains. Illustrates and describes an engine of somewhat peculiar design built for the Southern Railroad of Italy. 1100 w. R R Gaz—April 18, 1902. No. 47653.

American, British and Belgian Locomotives. On the report of Lord Cromer concerning the consumption of fuel on locomotives used on the Egyptian lines. 4500 w. Ir Age—April 24, 1902. No. 47641.

American Locomotive Construction. The first of a series of articles setting forth erroneous assumptions in regard to American locomotives, and discussing their construction and design. Ill. 3000 w. Engr, Lond—April 11, 1902. Serial. 1st part. No. 47604 A.

Atlantic Type Passenger Engine for the Illinois Central. Illustrated detailed description of engine built to be tested with a sample engine of the Prairie type. 800 w. Ry Age—April 18, 1902. No. 47642.

Baldwin Consolidation and 10-Wheel Locomotives, Southern Ry. Photographs and general dimensions of each type are given; the consolidation locomotives are for freight service and the 10-wheel engines for passenger service.

We supply copies of these articles. See page 487.

1200 w. Ry & Engng Rev—March 29, 1902. No. 47246.

British and Foreign Built Locomotives. Editorial on the recent conference of Indian Railway Engineers, and the subjects discussed. 800 w. Engng—April 11, 1902. No. 47597 A.

British, Belgian and American Locomotives in Egypt. Abstract of a parliamentary paper containing correspondence respecting the comparative merits of British and American locomotives in Egypt. Also editorial. 5600 w. Engr, Lond—April 4, 1902. Serial. 1st part. No. 47517 A.

Comparative Tests of Oil Burning Locomotives, Southern Pacific Railway. A report of interesting service tests. 600 w. Am Engr & R R Jour—April, 1902. No. 47340 C.

Compound Atlantic Type Passenger Locomotive. Illustrated description of the first of a number of heavy Atlantic type, Vauclain compounds with wide fire boxes for the C. B. & Q. Ry. 400 w. Am Engr & R R Jour—April, 1902. No. 47343 C.

Consolidation Freight Locomotive—Norfolk & Western Railway. Illustrated description of interesting engines known as the Class W. 900 w. R R Gaz—April 25, 1902. No. 47679.

Consolidation Switching Locomotives for the Chicago Union Transfer Railway. Engraving and brief description. 500 w. R R Gaz—April 25, 1902. No. 47681.

Double-Bogie Tank Locomotive, Northern Railway of France. Illustration with brief description. 300 w. Engr, Lond—March 21, 1902. No. 47302 A.

European Railway Jottings. Charles Rous-Marten. Describes the new British outside cylinder engines and the new valve gear designed by J. T. Marshall, now in course of experimental trial on the Great Northern Ry. 2000 w. Loc Engng—April, 1902. No. 47366 C.

Heavy 6-Coupled Suburban Locomotive. Illustrates and describes a locomotive in use on the New York Central & Hudson River Railroad. 700 w. Am Engr & R R Jour—April, 1902. No. 47342 C.

Heavy Double-End Suburban Locomotive for the New York Central. Illustrated detailed description of a type from which 16 have been ordered, and 6 are in service. 900 w. R R Gaz—March 28, 1902. No. 47220.

"Lake Shore" Type Tandem Compound Locomotive. Illustrated description of engines built for freight service on the Chicago Great Western Railway. 900 w. Am Engr & R R Jour—April, 1902. No. 47345 C.

Locomotive Improvement. A letter from David Joy giving a sketch of a novel locomotive design for a large engine for heavy work. 1300 w. Engr, Lond—April 11, 1902. No. 47605 A.

New Types of Freight Locomotives on the Atchison, Topeka & Santa Fe and Northern Pacific Rys. An illustrated article describing the present development in freight motive power equipment and new types of locomotives, and a traction-increasing device. 3900 w. Eng News—April 24, 1902. No. 47669.

Prairie Type Compound Freight Locomotives for the Atchison, Topeka & Santa Fe. Illustrated description of engines to use bituminous coal. 900 w. Ry Age—April 4, 1902. No. 47415.

Switching Engine for the Kansas City Belt. Illustrated description of a heavy switching locomotive especially designed for transfer work and pushing service. 700 w. Ry Age—March 28, 1902. No. 47240.

Tandem Compound Locomotive for Chicago Great Western. Illustrated description of heavy engines to be used in freight service. 900 w. Ry Age—April 11, 1902. No. 47499.

Test of Bismarck, Washburn & Great Falls Lignite-Burning Locomotive, No. 3. A report of test which proved conclusively that as a lignite-burning locomotive the machine is a success. 900 w. R R Gaz—March 28, 1902. No. 47219.

The Class H-6-a Consolidation Locomotive of the Pennsylvania. Illustrations showing the principal changes made in the H-6 consolidation freight locomotive and interesting details of this new type. 700 w. R R Gaz—April 4, 1902. No. 47391.

The Four-Cylinder Compound Express Locomotive for the I. R. State Railways of Austria. Iaroslav Iirdra. Illustrated description of an engine of the American (Atlantic) type. 600 w. Loc Engng—April 1902. No. 47364 C.

Wide Fire Box Consolidation Locomotive, Norfolk & Western Ry. General view, side elevation and sectional views with description. 900 w. Ry & Engng Rev—April 5, 1902. No. 47426.

Spreader Car.

The McCann Spreader Car. Illustrates and describes improvements that have been made in this car, and the character of some of the work handled. 1500 w. Ry & Engng Rev—April 19, 1902. No. 47644.

Tools.

The Value of Up-to-date Tools for Railroad Work. M. K. Barnum. Shows the saving made by installing new machinery, with comments on recent types and what they accomplish. Followed by general discussion. 4500 w. W Ry Club—March 18, 1902. No. 47535 C.

Valve Gear.

The Valve Motion That Promises to Save Forty Per Cent. Particulars in regard to the new gear being tried on the Great Northern Ry. of England. 1200 w. Loc Engng—April, 1902. No. 47368 C.

We supply copies of these articles. See page 487.

Water.

Railroad Water Supply. William Archer. An illustrated article describing the methods used on the A. T. & S. F. Ry. to supply water for locomotive purposes and for improving the quality. 3500 w. Ry Age—April 25, 1902. No. 47682.

The Water Question. The first of a series of articles prepared by a well-known chemist and engineer who has made a special study of the subject. Describes methods of overcoming objectionable conditions in water for locomotive boilers. 700 w. Am Engr & R R Jour—April, 1902. Serial. 1st part. No. 47347 C.

Wheels.

Chilled Cast Iron Car Wheels. C. H. Vannier. Extracts from an address delivered before the engineering students of Purdue University. Concerning the history of cast iron wheels and their improvements, tests, etc. 1500 w. R R Gaz—March 28, 1902. No. 47221.

The Cost of Car Wheels. Gives actual cost and car miles run on a large number of different lines. 1200 w. St Ry Jour—April 5, 1902. No. 47408.

NEW PROJECTS.

British Columbia.

The Railway Situation in British Columbia. S. J. McLean. An account of railways and proposed lines, with map. 2000 w. Ry Age—April 11, 1902. No. 47497.

Cuba.

The Cuban Railroad Law. Condensed abstract of the main features of the new code of laws for the government and regulation of the railroads recently issued by the military governor. 1500 w. R R Gaz—April 11, 1902. No. 47512.

Greece.

Railway Project in Greece. Information concerning the organization of the Piraeus-Larissa R. R. Co. Gives particulars of this important project. 800 w. U S Cons Repts, No. 1318—April 17, 1902. No. 47557 D.

PERMANENT WAY AND FIXTURES.

Austria.

New Railways in the Austrian Alps (Oesterreichs Neue Alpenbahnen). K. Imhof. A description of the new government railway in Bohemia, Galicia and Styria, including difficult grades and tunnels in the Austrian Alps. 2500 w. Schweizerische Bauzeitung—March 22, 1902. No. 47742 B.

Block Signalling.

Railway Stocks and Telegraphs—Recent Practice. A. T. Kinsey. Read before the Dublin Loc. Sec. of the Inst. of Elec. Engrs. Discusses the extension of block signal working on the Irish railways, where double lines of rails exist, and the introduction of the train staff block instrument where there is only a single line of rails. 5400 w. Elec Engr, Lond—April 18, 1902. No. 47806 A.

Construction.

The Morenci Southern Ry.—A Line With Five Loops. Brief illustrated description of an example of curious railway construction. 800 w. Ry & Engng Rev—April 26, 1902. No. 47814.

Improvements.

The Atlantic Avenue Improvements of the Long Island Railroad. The improvements will consist of an alternate subway and elevated road for 26,700 ft. east of the Flatbush Avenue terminal, removing these tracks from the street grade. Ill. 2500 w. R R Gaz—April 25, 1902. No. 47678.

Panama.

The Panama Railroad. E. W. Gregory. An illustrated article describing this railroad. 1000 w. Loc Engng—April, 1902. No. 47369 C.

Power.

The Power Question in Locomotive Repair Shops. R. W. Stovel. Abstract of a paper read before the Ry. Club of Pittsburg. The paper aims to give arguments and facts helpful in governing the selection of a power system. 1200 w. Ry Age—April 4, 1902. No. 47416.

Reconstruction.

Reconstruction of the Union Pacific Railroad. Illustrates and describes costly reconstruction work between Cheyenne and Evanston in Wyoming. 1000 w. Sci Am—April 5, 1902. No. 47385.

Shallow Tunnels.

Shallow Tunnels for Railways. The important part of the report of Lieut.-Col. A. H. Yorke on the Chemin de Fer Metropolitain de Paris. 3800 w. Arch't, Lond—April 11, 1902. No. 47578 A.

Shops.

New Shops at Du Bois, Pennsylvania. Illustrated description of shops for the Buffalo, Rochester & Pittsburg Railway, having a capacity of 200 locomotives per year. 1300 w. Am Engr & R R Jour—April, 1902. No. 47339 C.

Oregon Short Line Shops at Pocatello, Idaho. Illustrated description of these new shops and their equipment. 1200 w. Ry Age—March 28, 1902. No. 47241.

The Collinwood Shops of the Lake Shore. An illustrated description of new shops at Cleveland, which will be among the most complete in the country. 2000 w. Ry Age—April 11, 1902. No. 47498.

Spiral Curves.

Suggestion for a More Uniform Prac-

We supply copies of these articles. See page 487.

tice in Fixing the Lengths of Spiral Curves. W. D. Taylor. A discussion of the principles controlling these curves, with the writer's suggestion giving tables proposed for connecting the degree of curve, the superelevation, the maximum velocity and lengths of spiral. 2000 w. Eng News—April 17, 1902. No. 47554.

Station.

The Bordeaux New Railway Station. Illustrates and describes a fine central railway station in France. 800 w. Engng—April 11, 1902. Serial. 1st part. No. 47594 A.

Ties.

Combination Concrete and Steel Railway Ties. Illustrates and explains the construction of a tie designed by G. H. Kimball now being tried on the Pere Marquette R. R. 1100 w. Eng News—April 3, 1902. No. 47458.

Tracks.

Track Elevation in Newark, N. J. Clarence H. Baily. A report of the work of changing and elevating the tracks through the city, being done by the Lackawanna, the Pennsylvania and the Central of New Jersey roads. 2000 w. R R Gaz—April 25, 1902. No. 47677.

Tunnelling.

See Civil Engineering, Construction.

TRAFFIC.

Interchange.

Report of the Committee on Revision of the Rules of Interchange. Report, discussion and recommended changes. 6000 w. W Ry Club—March 18, 1902. No. 47536C.

Per Diem.

Errors in Calculating an Average Per Diem Rate. Two letters discussing the recent letter of Mr. Midgley. 1700 w. R. R Gaz—April 4, 1902. No. 47389.

Mileage vs. Per Diem. W. M. Prall. Discusses the present conditions and what may be expected under per diem; and how the cars shall be cleared at terminals so that the car owner may be protected, if per diem is adopted. 3300 w. St. Louis Ry Club—March 14, 1902. No. 47230.

Per Diem from a Terminal Standpoint. Jno. J. Baulch. Briefly notes some features of car service from the terminal point of view. 2300 w. St. Louis Ry Club—March 14, 1902. No. 47231.

The Per Diem Reform. Editorial discussion of this question. 1800 w. R R Gaz—April 11, 1902. No. 47514.

Rates.

Competition and Railway Rates. Charles A. Prouty. An address before the Illinois Mfrs. Assn. at Chicago. A discussion of present conditions and the danger of railroad monopoly. 5500 w. Ry Age—April 4, 1902. No. 47414.

South Africa.

Railway Development in Federated South Africa. A. Cooper Key. A discussion of the conditions involved in the reorganization of the South African railways, with especial reference to the needs of the Transvaal and Orange river colonies. 4000 w. Engineering Magazine—May, 1902. No. 47772 B.

Tonnage Indicator.

Daly's Train-Resistance Computer. Illustrated detailed description of a mechanical arrangement for quickly computing the resistance of a train of cars. 1600 w. R R Gaz—April 25, 1902. No. 47680.

Tonnage Rating.

Tonage Rating of Locomotives. W. M. Ray. Concerning the methods of making the rating, with information received in answer to questions addressed to different roads, tests, diagrams, etc. 4000 w. Jour Assn of Engng Socs—Feb., 1902. No. 47211 C.

MISCELLANY.

Europe.

European Railway Jottings. Charles Rous-Marten. Reviews the principal features of the past year's progress in locomotive engineering in Great Britain, and the Continent. 1500 w. Loc Engng—March, 1902. Serial. 1st part. No. 46646 C.

Some Observations on European Railways. Tipton S. Blish. Descriptive of rolling stock, and customs. 2000 w. St Louis Ry Club—Feb. 14, 1902. No. 46628.

Mexico.

The Mexican Railroad System. Victor M. Braschi. Gives a historical summary of the railroads, their present condition, and a description of a railroad journey on lines of the Mexican railways. 6400 w. Trans Am Inst of Min Engrs—Nov., 1901. No. 47539 D.

Organization.

Railroad Organization. Arthur Hale. A paper read at New York University. Discusses the organization of the entire service. 4000 w. R R Gaz—April 11, 1902. No. 47513.

Regulation.

Some Principles of Railway Regulation. H. T. Newcomb. A discussion of rates, legislation, etc., followed by general discussion. 10500 w. N Y R R Club—March 20, 1902. No. 47534.

Turkey.

Railways in Turkey. A brief summary of the conditions of the railways in the Ottoman Empire, showing their extent, amount of traffic, etc. 1700 w. U S Cons Repts, No. 1315—April 14, 1902. No. 47533 D.

We supply copies of these articles. See page 487.

STREET AND ELECTRIC RAILWAYS

Accidents.

Liverpool Overhead Electric Railway. Abstract of the report on the accident at the Dingle station. 1200 w. Engr, Lond—March 28, 1902. No. 47455 A.

Berlin.

The Berlin Elevated and Underground Railway. Illustrated description of the 13-mile rapid transit electric railway in Berlin, explaining mainly the superstructure and power station. 3000 w. Eng Rec—April 26, 1902. No. 47647.

The Berlin Overhead and Underground Electric Railway. Illustrated detailed description with brief resumé of the history of the undertaking. 2700 w. Elec Rev, Lond—April 18, 1902. Serial. 1st part. No. 47807 A.

The New Electric Railroad at Berlin. A descriptive account of the elevated and underground electric railroad recently opened. 1100 w. R R Gaz—April 4, 1902. No. 47393.

The New Electric Underground and Elevated Railway at Berlin. An account of this recently completed enterprise, showing the novel features and German municipal methods. Ill. 2200 w. U S Cons Repts, No. 1302—March 29, 1902. No. 47-200 D.

The Metropolitan Railways of Berlin (Les Chemins de Fer Métropolitains de Berlin). R. Philippe. Fully illustrated description of the system of railways of Berlin, including the earlier steam roads and the latest electric system. Two articles. 8000 w. Two plates. Génie Civil—March 15, 22, 1902. No. 47700 each D.

Brooklyn Bridge.

The Brooklyn Bridge Railroads. Julius Meyer. Discusses the connection desirable between the Manhattan ends of the Brooklyn, Williamsburg and Navy Yard bridges, trolley terminals, etc. Ill. 1800 w. R R Gaz—April 18, 1902. No. 47652.

Car Driving.

The Raw Material for Electric Car Driving. F. T. Stewart. Remarks on the changed employment of men connected with tramways, by the change to electricity and some of the disadvantages of the service. 1800 w. Elec Engr, Lond—March 21, 1902. No. 47285 A.

Cars.

Some Points in the Equipment of Electric Tram Cars. W. G. Rhodes. Abstract of a paper read before the Manchester section of the Inst. of Elec. Engrs. Discusses points of equipment that will enable one to select the most suitable type of car for a particular route. 5000 w. Mach Engr—March 22, 1902. No. 47283A.

Competition.

Competition of Steam vs. Electric Parallels. C. H. Davis. Read before the Canadian Soc. of Civ. Engrs. Showing that it is the created or induced traffic of electric roads and not that taken from parallel steam roads, which makes their success, and that if the same methods were applied to steam roads the results would be the same or greater. 4200 w. St Ry Jour—March 29, 1902. No. 47233 D.

Dispute.

The Eastern and South African Telegraph Company, Limited, v. Cape Town Tramway Companies, Limited. Reviews the cause of this dispute, and the first decision, discussing the appeal. 2300 w. Elec Rev, Lond—March 28, 1902. No. 47438 A.

Electric Railways.

Problems of Electric Railways. J Swinburne and W. R. Cooper. Read before the Inst. of Elec. Engrs. Discusses the series distribution of power for railways, especially for short lines. Its use for main lines is also considered; also other systems. 5200 w. Elect'n, Lond—April 4, 1902. Serial. 1st part. No. 47426 A.

Electrolysis.

Damaging Effects of Electrolysis on Pipe. Reports of its action at St. Paul, Minn., Dayton Ohio, and Taunton, Mass., with illustrations. 5300 w. Fire & Water—April 19, 1902. No. 47627.

Electrolysis Decision in Dayton. Slightly abstracted report of the decision rendered by Judge O. B. Brown. 12300 w. St Ry Jour—April 12, 1902. No. 47482D.

Germany.

An Analysis of Street Railway Operations in Germany. Wilhelm Mattersdorff. Abstract of an article in the *Zeitschrift fur Kleinbahnen*. Data relating to traffic density, gross receipts, operating expenses, etc. Diagrams. 3800 w. St Ry Jour—April 5, 1902. No. 47411 D.

Opening of the Electric Elevated and Underground Road, Berlin, Germany. An illustrated account of this important engineering work. 900 w. Elec Wld & Engr—March 1, 1902. No. 46617.

Statistics of Electric Railways in Germany (Statistik der Elektrischen Bahnen in Deutschland). The usual annual tabulated review of the progress of electric railway construction and operation; the data are brought down to October, 1901. 10000 w. Elektrotech Zeitschr—March 27, 1902. No. 47746 B.

We supply copies of these articles. See page 487.

High-Speed.

The High-Speed Electric Railway between Manchester and Liverpool (Elektrische Schnellbahnen Zwischen Manchester und Liverpool). F. B. Behr. A full account of the proposed Behr high-speed mono-railway from Manchester to Liverpool. Two articles 10000 w. Zeitschr d ver Deutscher Ing—April 5, 12, 1902. No. 47714 each D.

Hudson Valley.

The Hudson Valley Railway. An illustrated description of the characteristics and operating details of an electric road which operates in competition with a steam road and a canal. 5200 w. St Ry Rev—April 15, 1902. No. 47636 C.

Interurban.

Overhead and Track Construction in Connection with Interurban Railways. Gilbert Hodges. Address before the New England St. Ry. Club. Urging a good, substantial, well laid track, and overhead construction, discussing points in detail. 4500 w. St Ry Jour—April 19, 1902. No. 47632 D.

The Brockton & Plymouth Street Railway. Illustrated detailed description of the line and its operation. 7200 w. St Ry Jour—April 5, 1902. No. 47407 D.

Italy.

The Electric Tramways of Leghorn, Italy. Enrico Bignami. An illustrated description of the city and suburban electric railway lines of an Italian seaport. 1000 w. Elec Rev, N Y—April 19, 1902. No. 47639.

Liverpool.

The Liverpool Overhead Railway New Equipment. An illustrated article describing the equipment of trains with new motors which enable the trip to be made in about 20 minutes that formerly required 32 minutes. 1000 w. Engr, Lond—March 21, 1902. No. 47301 A.

Modern Practice.

Discussion of Papers by Messrs. Armstrong and Berg on Modern Electric Tramway Practice. Discussion at Buffalo, Aug. 2d 1901. 14000 w. Trans Am Inst of Elec Engrs—March 1902. No. 47571 D.

Municipal Ownership.

Municipal Ownership and Operation of Street Railways. H. M. Sloan. From an article published in the *Calumet Record*. Presents practical facts, and discusses methods of disposing of difficulties and securing compensation to the city. 4000 w. St Ry Rev—April 15, 1902. No. 47637C.

Potential Drops.

Potential Drop on Tramway Rails. Gisbert Kapp. Read before the Electrotechnischer Verein. Describes a rail booster system, illustrating by an example, 3000 w. Elect'n, Lond—April 11, 1902. No. 47584 A.

Power Plants.

Power Plants of the St. Louis Transit Co. Describes and illustrates the Central Power station in the present number. 3000 w. Eng News—April 3, 1902. No. 47459.

The Evolution of Electric Railway Power Plant Apparatus, as illustrated by the Cedar Avenue Station of the Cleveland Electric Railway Company. H. W. Woodward. An illustrated descriptive article. 3500 w. Engr, U S A—April 1, 1902. No. 47352.

Repair Shops.

Repair Shops of the North Jersey Street Railway Co. Illustrates and describes machines and devices for facilitating repairs, giving a list of prices for all street-car repair work. 5200 w. St Ry Rev—April 15, 1902. No. 47638 C.

Signals.

Block Signals on Heavy Electric Railroads. Reviews some of the principal work that has been done on the electric elevated and subway roads, giving illustrated descriptions of two systems. 4500 w. St Ry Jour—April 5, 1902. No. 47409D.

South Africa.

Camps Bay, Cape Town, and Sea Point Tramways. Illustrates and describes the construction and equipment of this line. 3000 w. Tram & Ry Wld—March 13, 1902. No. 47313 B.

South Lancashire.

The South Lancashire Electric Traction and Power Company, Limited. Map and information of one of the most extensive schemes for the application of electric traction in the United Kingdom. 3000 w. Tram & Ry Wld—March 13, 1902. No. 47316 B.

Sub-Station.

Sub-Station Plant of the London United Tramways. Illustrated description of the sub-station. Tram & Ry Wld—March 13, 1902. No. 47314 B.

Vibrations.

Vibration on Railways. Editorial review of Mr. Mallock's report on the complaints against the Central London Railway. 2500 w. Engng—April 11, 1902. No. 47596 A.

Worcester.

The Worcester Consolidated Street Railway Company. Illustrated description of an extensive interurban system in Massachusetts, its power stations, rolling stock, etc. 4000 w. St Ry Jour—April 5, 1902. No. 47410 D.

We supply copies of these articles. See page 487.

EXPLANATORY NOTE—THE ENGINEERING INDEX.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language*, together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

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CARD INDEX.—These pages are issued separately from the Magazine, printed on one side of the paper only, and in this form they meet the exact requirements of those who desire to clip the items for card-index purposes. Thus printed they are supplied to regular subscribers of THE ENGINEERING MAGAZINE at 10 cts. per month, or $1.00 a year; to non-subscribers, 25 cts. per month, or $3.00 a year.

THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

Alliance Industrielle. *m.* Brussels.
American Architect. *w.* Boston, U. S. A.
American Electrician. *m.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Gas Light Journal. *w.* New York.
American Geologist. *m.* Minneapolis, U. S. A.
American Jl. of Science. *m.* New Haven, U.S.A.
American Machinist. *w.* New York.
Am. Manufacturer and Iron World. *w.* Pittsburg, U. S. A.
American Shipbuilder. *w.* New York.
American Telephone Journal. *w.* New York.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. d Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architectural Record. *qr.* New York.
Architectural Review. *s-q.* Boston, U. S. A.
Architect's and Builder's Magazine. *m.* New York.
Armee und Marine. *w.* Berlin.
Australian Mining Standard. *w.* Sydney.
Autocar. *w.* Coventry, Eng.
Automobile Magazine. *m.* New York.
Automotor & Horseless Vehicle Jl. *m.* London.
Brick Builder. *m.* Boston, U. S. A.
British Architect. *w.* London.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bulletin Am. Iron and Steel Asso. *w.* Philadelphia, U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bulletin Scientifique. *m.* Liege.
Bull. Soc. Int. d Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bull. Int. Railway Congress. *m.* Brussels.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Montreal.
Canadian Mining Review. *m.* Ottawa.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris
Consular Reports. *m.* Washington.
Contemporary Review. *m.* London.
Deutsche Bauzeitung. *b-w.* Berlin.
Domestic Engineering. *m.* Chicago.
Electrical Age. *m.* New York.
Electrical Engineer. *w.* London.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electrical Times. *w.* London.
Electrical World and Engineer. *w.* New York.
Electrician. *w.* London.

Electricien. *w.* Paris.
Electricity. *w.* London.
Electricity. *w.* New York.
Electrochemist & Metallurgist. *m.* London.
Elektrizität. *b-w.* Leipzig.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricita *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Cleveland, U. S. A.
Engineers' Gazette. *m.* London.
Engineering. *w.* London.
Engineering and Mining Journal. *w.* New York.
Engineering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penn'a. *m.* Pittsburg, U. S. A.
Fire and Water. *w.* New York.
Foundry. *m.* Cleveland.
Gas Engineers' Mag. *m.* Birmingham.
Gas World. *w.* London.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav. Pubb. e. d. Str. Ferr. *w.* Rome.
Glaser's Ann. f. Gewerbe & Bauwesen. *s-m.* Berlin.
Horseless Age. *w.* New York.
Ice and Refrigeration. *m.* New York.
Ill. Zeitschr. f. Klein u. Strassenbahnen. *s-m.* Berlin.
Indian and Eastern Engineer. *m.* Calcutta.
Ingeneria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron & Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland.
Jour. Am. Foundrymen's Assoc. *m.* New York.
Journal Assn. Eng. Societies. *m.* Philadelphia, U.S.A.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Journal of Sanitary Institute. *qr.* London.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery. *b-m.* Fort Monroe, U.S.A.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, Mass.
Locomotive. *m.* Hartford, U. S. A.
Locomotive Engineering. *m.* New York.
Machinery. *m.* London.
Machinery. *m.* New York.
Madrid Científico. *t-m.* Madrid.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, U. S. A.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Metal Worker. *w.* New York.
Métallurgie. *w.* Paris.
Minero Mexicano. *w.* Mexico.
Minerva. *w.* Rome.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci. Press. w. San Francisco, U.S.A.
Mining Journal. *w.* London
Mining Reporter. *w.* Denver, U. S. A.
Mitt. aus d Kgl Tech. Versuchsanst. Berlin.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. m. Vienna.
Modern Machinery. *m.* Chicago.
Monatsschr. d Wurtt. Ver. f Baukunde. *m.* Stuttgart.
Moniteur Industriel. *w.* Paris.
Mouvement Maritime. *w.* Brussels.
Municipal Engineering. *m.* Indianapolis, U. S. A.
National Builder. *m.* Chicago.
Nature. *w.* London.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Nineteenth Century. *m.* London.
North American Review. *m.* New York.
Oest. Wochenschr. f. d. Oeff Baudienst. *w.* Vienna.
Oest. Zeitschr. f. Berg- & Hüttenwesen. *w.* Vienna.
Ores and Metals. *w.* Denver, U. S. A.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Power Quarterly. New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Proceedings Engineers' Club. *qr.* Philadelphia, U. S. A.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Progressive Age. *s-m.* New York.
Quarry. *m.* London.
Railroad Digest. *w.* New York.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago.
Review of Reviews. *m.* London & New York.
Revista d Obras. Pub. *w.* Madrid.
Revista Tech. ed Agr. *b-m.* Catania.
Revista Tech. Ind. *m.* Barcelona.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Gen. des Sciences. *w.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Gen. d Ferrovie. *w.* Florence.
Rivista Marittima. *m.* Rome.
Sanitary Plumber. *s-m.* New York.
Schiffbau. *s-m.* Berlin.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Stahl und Eisen. *s-m.* Düsseldorf.
Steam Engineering. *m.* New York.
Stevens' Institute Indicator. *qr.* Hoboken, U.S.A.
Stone. *m.* New York.
Street Railway Journal. *m.* New York.
Street Railway Review. *m.* Chicago.
Telephone Magazine. *m.* Chicago.
Telephony. *m.* Chicago.
Tijds. v h Kljk. Inst. v Ing. *qr.* Hague.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. of Civil Eng. *m.* New York.
Trans. Am. Soc. of Heat & Ven. Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland Glasgow.
Transport. *w.* London.
Western Electrician. *w.* Chicago.
Wiener Bauindustrie Zeitung. *w.* Vienna.
Yacht. *w.* Paris.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a. S.

IMPROVED MACHINERY

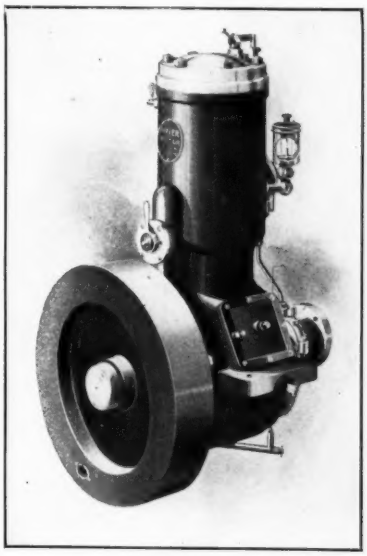
New Processes and New Appliances

The matter here published is not paid for, nor can it be classed as advertising. But as the information is necessarily obtained from those who offer the appliances for sale, it is proper to say that the manufacturers, rather than ourselves, are responsible for the statements made.

Lozier Marine Gasoline Engine.

THE Lozier Marine Gasoline engine is of the two-cycle type, and as engines operating on this principle have recently become very popular for marine use, the claims of the builders of this engine are worthy of consideration as an example of the rapid progress which has been made toward ultimate perfection.

As engines of this class are usually intended to be operated by the owners of yachts—who may have limited mechanical knowledge—simplicity of construction and a minimum number of working parts are most important considerations, and these the Lozier engine possesses in a high degree. Compactness is another noticeable attribute of the Lozier motor, making it especially valuable for marine use as, the motor being so small, it occupies comparatively little space in a boat.



SINGLE CYLINDER LOZIER LAUNCH ENGINE.

The water circulation is most complete, keeping the engine cool at all times, and preventing the annoying smell and odor from heated oil cups noticeable on so many marine engines. The pump is a rotary, and as it has no piston or packing, it is practically indestructible and requires no attention or repairs.

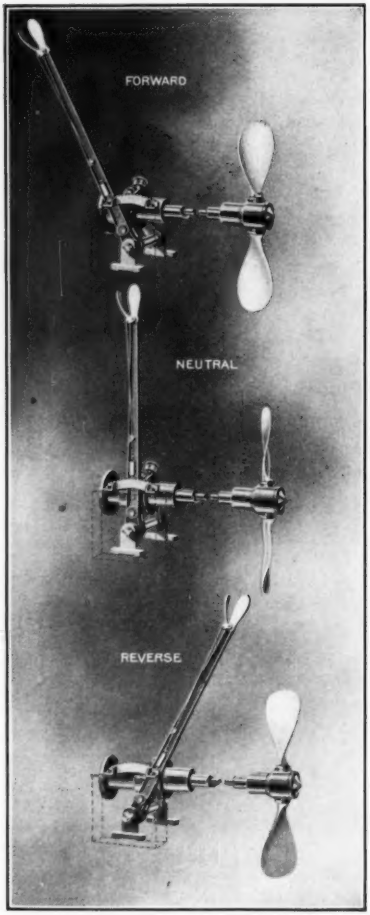
One advantage of the Lozier engine which will be, perhaps, more appreciated by the owner and user of the engine than any other one point is total absence of noise from the exhaust. The Lozier Company have a system of muffling which enables the engine to exhaust below the waterline, thus entirely silencing the noise, and at the same time not reducing the power of the engine in the least.

The Lozier engine is fitted with a special air-drying jacket whereby the air is dried before being admitted to the vaporizer, so that the engine will work equally well in wet, rainy weather and on the dryest summer day. A special throttling device located on the front of the cylinder of the Lozier engine enables the speed to be reduced positively by reducing the *quantity* of mixed vapor admitted to the firing chamber. The proportion of gas and air admitted to the engine are never varied, consequently the explosive quality of the gas is in no manner changed, the throttling being done by decreasing the quantity of gas which has already been mixed in proper proportions to be ideally explosive.

The engines are all adjusted to run continuously in one direction, and the launches are driven either ahead or astern by means of a propeller with reversible blades which

can be conveniently and quickly changed from a right-handed to a left-handed screw while the engine is running.

In addition to these special features there are a number of other improvements which the Lozier Company have made, all of

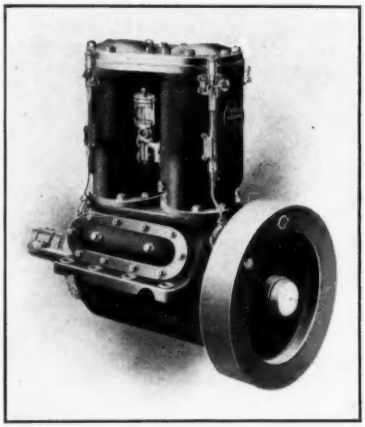


REVERSING BY CHANGING THE PITCH OF PROPELLER BLADE.

which are practical, sensible devices without any suggestion of "freakishness."

The Lozier Company were the originators and, for many years, the builders of Cleveland bicycles, and many of their most skilled mechanics are employed in their model factories which were erected at Plattsburg, N. Y., where their general offices are also located. This factory occupies an extensive water-front on Lake Champlain and is equipped with the very latest electric-driven automatic machinery, all of which has been installed with the sole view to building the Lozier Marine Gasoline Engine.

The Lozier Motor Company issue a very attractive and handsomely illustrated catalogue, containing detailed information about



DOUBLE CYLINDER LOZIER LAUNCH ENGINE.

their engines and launches, which will be cheerfully furnished on application.

Forbes Patent Die Stock.

ALL who have had experience in the cutting and threading of wrought iron pipe, and especially the larger sizes, know well the difficulty with which it is attended. Either a hand die stock with its long handles, or a cumbersome, heavy, and expensive power machine must be used; in the former case, it is rarely that anything larger than 4 inch pipe is attempted, and even then it requires four men to do the work, and very hard work it is; in the latter case, the machine is not portable, and all the pipe has to be carted to and from it, and, as these machines take up so much room and are so

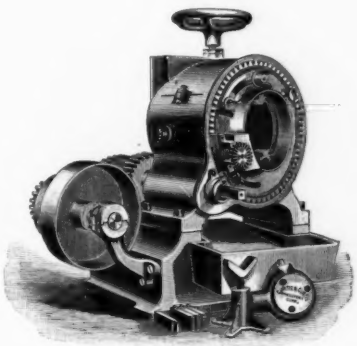
very heavy, it is impracticable to use them in confined places, or in isolated mills.

The accompanying illustrations show the Forbes Patent Die Stock, manufactured by The Curtis & Curtis Co., of Bridgeport, Conn., which, it is claimed, meets the requirements of the case without the above disadvantages.

The machine consists of a die-carrying gear supported and surrounded by a shell and actuated by a small pinion imbedded in the side of the shell and working on the large gear, with the pipe vise attached to the back of the machine. To operate it, the pipe is placed through the pipe vise with the end to be threaded against the back of the dies. The die-carrying gear is then revolved, by means of a crank on the end of the pinion; as the dies revolve, the gear is drawn back into the shell and the dies are thus brought onto the pipe. These dies are adjustable to any variations of fittings, and, when the thread is cut, they can be opened and the pipe taken out without running back or stopping the machine. In cutting off pipe, the gear is shoved back in the shell, and held by a stop, so as to give it a rotary without a traveling motion. A blade cutter is then inserted in the gear, which is automatically fed forward as the gear revolves.

The advantages claimed for this machine are: It is portable, and can be carried from place to place, and the pipe cut on the spot without the delay and expense of carrying it to the machine, which is particularly important for plantation work. In case it is desired to thread the end of a pipe without disconnecting it, and where only one end is exposed, the machine can be slipped on and the work done without taking the pipe down. On account of the great leverage obtained by the small gear working on the larger, pipe even as large as 12 inches can be threaded by one man with ease, while, on 2 inch and 3 inch pipe, a boy will do the work with only one hand on a crank. Dies can be sharpened by grinding without first drawing the temper, and when one of the set is lost or broken, a new one can be supplied without replacing the set. They draw back out of the way when thread is out, yet always cut standard sizes, and are adjustable to any variations of fittings. The shells are adjustable for wear, which greatly prolongs the life of the machine.

These machines are made in a great variety of sizes to meet almost any range desired from ¼ inch to 12 inches for hand power. By the addition of a cast iron base, with the necessary gearing and countershafting, they can be fitted to run by power, so that they can be used as a power machine



in the shop, or taken from the base and used on outside work as a hand machine.

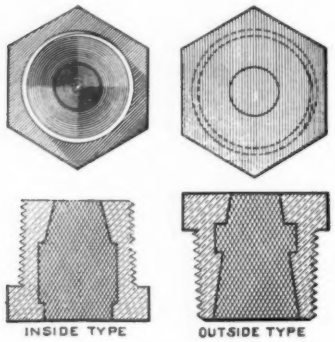
When desired, an engine or dynamo is directly connected with them, so that they can be run by steam or electric current, without the necessity of having other power available.

Fusible Plugs for Boilers.

THE recent action of the United States Treasury Department in enforcing the provisions of Section 4436 of the United States Revised Statutes, regarding the specifications as to the manufacture of fusible plugs, has attracted considerable attention to this article.

Fusible plugs have been used in boilers for a great many years, and the Government, recognizing the important function of this boiler accessory, requires that all plugs on boilers of steam vessels should be made of bronze and have no other filling but pure Banca tin.

There have been placed on the market many plugs filled with fusible alloys composed of other metals, which, although melting at very near the same point as Banca tin, are not absolutely reliable. Since the disaster at Philadelphia last fall, the United States Steamboat Inspection Service of the Treasury Department has taken cognizance



of the fact that inferior plugs were offered for sale, and issued a circular requiring that all fusible plugs should be filled with pure Banca tin and stamped with the manufacturer's name, and that an affidavit setting forth this fact should be filed with the inspector having charge of the boiler inspection at whatever place the plugs were used.

For a number of years the Lunkenheimer Company have manufactured fusible plugs, all of which comply with these specifications and, having made affidavit before the United States Steamboat Inspection Service to this effect, these plugs are accepted by all inspectors throughout the United States.

Herewith are illustrated two forms of plugs; namely, the outside and inside patterns, which are to be screwed in either from the inside of the boiler or from the outside through the fire box or shell.

These plugs are manufactured by the Lunkenheimer Company, of Cincinnati, Ohio, who will be pleased to give further particulars upon application.

Lifting Jacks.

THERE is no more essential or useful tool than a jack, which is like the brake on an automobile, in the respect that when it is needed, it is needed badly. Probably no tool, unless it be a crow-bar, must stand rougher usage, and the fundamental qualification of a good jack is that it be well made and durable.

The Lever Jack has displaced the slow, cumbersome Hydraulic Jack in undertaking loads weighing 15 tons or less, because it is quicker, more portable and less expensive in first cost and in cost of operation.

The Barrett Jack has become a standard on account of its design and construction, both of which render it easy to handle and operate, quick, powerful and durable. This jack is made in seventeen sizes, ranging from one ton to fifteen tons capacity. For uses in the machine shop or foundry, a Barrett Jack has been especially designed, having a lifting capacity of five tons, dead weight, and on account of its being comparatively light, it is easily carried and handled. This particular jack stands 16 inches high when the lifting bar is at the lowest point, and it raises its load to a height of 8 inches. Like all of the Barrett Jacks, its frame is constructed of refined malleable iron, and all its working parts of high grade steel, its lifting bar being drop forged from steel. All parts are machine finished to insure an easy movement, and every detail is carried out perfectly, which adds to the safety as well as to the life and efficiency of the jack. For several years the Barrett Jacks have been adopted as a standard by nearly all of the leading railroads and street railways of the United States, for whose requirements both track (or trip) jacks, and automatic lower-

ing jacks are employed. A Barrett Jack of one ton capacity has recently been placed on the market, for automobile purposes, although it is also adapted to light machinery work. For general lifting purposes the Barrett five ton and ten ton Automatic Lowering Jacks are used almost entirely, as they are suitable for every lifting requirement not exceeding their capacity.

The design and construction of the Barrett Jacks is the result of twenty years' experience, and it is a fact that their life

of usefulness is much longer than that of the ordinary lifting jack. They are also much less liable to get out of repair, which is an important item, and which is substantial evidence of their worth.

Barrett Jacks cover a wide field of usefulness and adaptation and for every lifting requirement there is one of these jacks to suit. They are manufactured exclusively by The Duff Manufacturing Company of Pittsburg, Pa., who own all the Barrett patents, and who have an extensive plant at Allegheny, Pa., where they confine their business to making jacks of all sizes and capacities.

Novel High Duty Pumping Engine.

A compensating boiler feed pump, designed by Charles L. Heisler, was described in a paper read at the Cincinnati meeting of the American Society of Mechanical Engineers, in May, 1900, and printed in Vol. XXI. of the Transactions. This pump had a 7 in., 10 in., 14 in. x 10 in. steam end, and a 4 in. x 10 in. duplex water end, and gave as an average from several tests, an indicated horse power on 26 pounds of steam per hour, running noncondensing, with 110 pounds steam gage pressure at the pump.

The results obtained from this small engine were so satisfactory that they justified the construction of an engine having a capacity of four million gallons per 24 hours. The latter engine showing the same general characteristics as the small engine, so there was no hesitation in taking orders for seven, eight and ten million gallon engines, one of which is illustrated for the first time in this paper, and a general description of which may be of interest.

When working out the design of this engine, the object was to obtain a high commercial efficiency, rather than to secure the greatest possible refinement thermodynamically, without regard to first cost and the maintenance of auxiliaries, necessary for securing the highest thermodynamic efficiency. Steam cylinder jackets and reheaters are omitted on this engine. A Richardson balanced locomotive slide valve is used in the high pressure steam chest; and plain slide valves are arranged in the intermediate and low pressure steam chests. The intermediate steam chest is made separate from the cylinder and of cylindrical form for obtaining strength and large receiver capacity. The cylinders are lagged in the usual manner with nonconducting material. Their diameters are 18 in.-26 in.-and 44 in. and 24 in. stroke. The double acting plunger is 18 in. in diameter.

The compensating mechanism has been fully described in the paper referred to, and consists of two pair of rocker arms mounted upon the centrally located air chamber, and connected by the floating side rods, one of which is shown in a horizontal position nearest the water end, by the general view. The other rod is hidden by the air chamber.

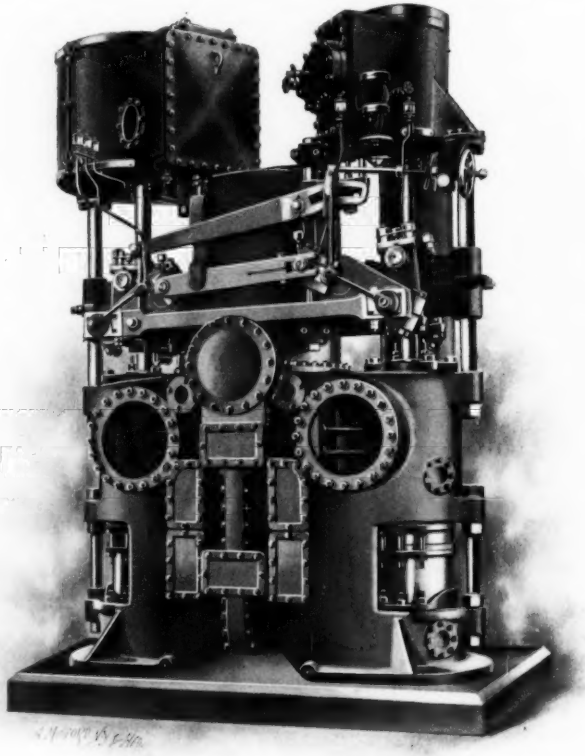
Under usual and normal conditions, the compensating floating side rods are in tension, so the main rocker arm bearings thrust against the air chamber, which is heavily braced inside so as to give a rigid support for the bearings.

The water end may be of any desirable construction, either with inside or outside packed plungers. In these engines it is usual to give each valve deck from 130 to

170 per cent. net valve area as compared with the plunger area. The water passages have approximately the same proportion of cross section.

Since the stroke is fixed in length and positive, no trouble is experienced in starting, or when exhausting the air from a long suction line, even when lifting 25 feet, so foot valves are unnecessary, and it has been found preferable to have a free and uninterrupted passage from the well to the suction valves. The screens are preferably arranged in the well so there will be a suction pool back of the screens for the suction pipes, and are also constructed so one can be cleaned while the other is in service. The two independent suction inlets are at the highest point on the water end, and on either side, there being four suction openings, two for the suction pipe and the two on the opposite side, opening into large air chambers, one of which is shown back of the high pressure crosshead.

Refined duty tests have not yet been made on this engine. The data obtained, however, show that the engine will give a steam economy comparing favorably with that from fly wheel engines when fitted with slide valves, working triple expansion, and cutting off at from 3/8 to 5/8 stroke in the high pressure cylinder. Indicator cards taken from the large engine are like those taken from the small engine already referred to.



HEISLER PUMP.

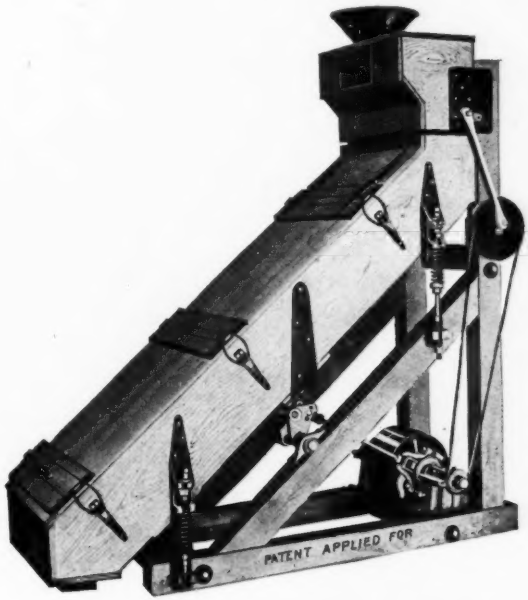
Engines are now being developed for 15 to 20 million gallons' capacity and fitted with Corliss valve gear. For average conditions and powers under 150 I. H. P. and where simplicity is most desirable, plain slide valves are used. The valve gear, although very simple, gives a quick opening and closing action.

The compensating mechanism is also being successfully applied in compressing air, and any further information regarding these engines will be gladly furnished by the manufacturer, Charles L. Heisler, of Erie, Pa.

Sturtevant Toggle Separator.

INCLINED shaking screens, although comparatively new, have, because of their extraordinary capacity nearly displaced all other separating devices within their field of usefulness. It would be untrue to say, that durability has not also been an important factor in their adoption. Inclining a screen has much the same practical effect as reducing the size of its meshes, and therefore, a comparatively coarse wire on a steeply pitched screen may be used for fine separations. This explains their lasting qualities. The fact that heavy wire clothing is more durable than wire of delicate construction is obvious.

The Sturtevant Mill Company of Boston, Mass., have made special studies of screen constructions, and effected important improvements in inclined screens. Their separators have four screens, (48 square feet in all), placed, and firmly held, one over another, in a strong box 2 feet wide and 6 feet long. Each screen is a substantial construction, and easily handled. Each receives equal feed, evenly spread over the wire surfaces. One outlet discharges the tailings, another the fines. It has been found to be practically impossible to spread any substance evenly over a large screen. Wide separators are weak affairs.



The construction of the Sturtevant screen has much to commend it. It takes up very little space. The box is supported on springs and shaken by a toggle. The toggle is connected with a driving pulley and for every revolution of the pulley, it shakes the box four times. Owing to the gearing the power to operate is but a small fraction of that

usually required by screens of large capacity.

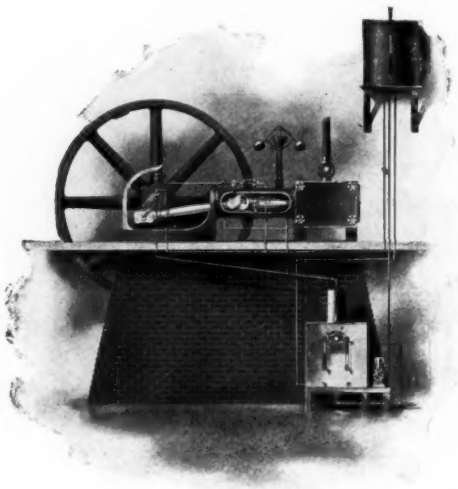
These improvements have reduced inclined separators to about one-fourth their former size, while at the same time a great deal of strength has been added to the machine itself. By setting the toggle to vibrate the box and its screens vertically, another advance has been attained which means a further increase in the capacity of the vertical separator. In tests it was noticed that vertical screens when shook, threw the material on it upward in a vertical line. Obviously the material would thereupon fall back to the point whence it started, all the material sliding down while on the wires. Thus perfectly thorough screening was secured, the entire surface being used. Vertical vibration requires no theory to prove its practical advantages. It proves itself in very considerably increased outputs.

Automatic Lubrication.

THE change in the engine room of to-day as compared with that of only a decade ago, has been almost revolutionary, and the equipment shows vast improvement in almost every particular. One point, however, and that a most important one in the economical operation of machinery, has been strangely eglected, and the question of the automatic lubrication by mechanical means of main-engine bearings, slides, eccentrics, crank-pins and other parts has, until recently, received far less attention than it deserves.

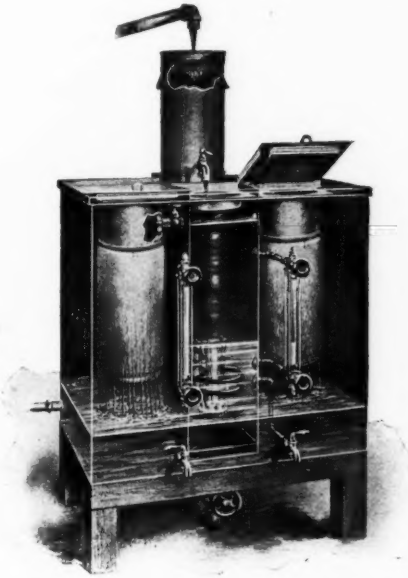
This problem has now been successfully solved in an effectual manner by the White Star Gravity Filtering System, employing the duplex and multiplex types of White Star Oil Filter, as designed and installed by the Pittsburgh Gage & Supply Company, Pittsburgh, Pa., and illustrated herewith.

A proper conception of the advantages of such an equipment will be gained when it is understood that a complete pipe system for oiling dispenses with 80% of the attendant labor by automatically handling all the oil applied to or released from the machinery. The loss by friction and its attendant expense for repair are reduced to a minimum by having the bearings continually supplied with an abundance of lubricant, while the waste inseparable from hand oiling by cans is entirely obviated.



In addition to this, a remarkable saving in the cost of lubrication is effected by the White Star Oil Filter, which thoroughly

purifies every drop of oil discharged from the machines, delivering it again to the system in perfect condition for use over and over again. In the entire process, the only loss of oil is from vaporization, as the pipe system prevents all waste.



DUPLEX TYPE, WHITE STAR OIL FILTER.

The oil is fed to the several cups by gravity, from the elevated reservoir, and, after passing through the bearings is carried in piping to the filter, where it is purified and returned by the pump to the storage tank above. The third pipe carries any surplus back to the filter and prevents overflow. The supply of oil is thus continuous and uniform, securing the most desirable results. The operation of cleaning the oil is one of interest, and may be seen in the sectional view accompanying. The impure oil enters the auxiliary tank on top of the main body, and is drained through a removable screen, discharging into water kept at a moderate temperature by means of the steam coils shown. By continued action of the heat, the oil becomes thinned, and all water and heavy impurities are rapidly separated from it by gravity, the former being automatically carried off by an overflow pipe at the back, and the latter, accumulating at the bottom of the chamber, are flushed out occasionally through a drain connection.

The constant admission of oil to the separating chamber eventually causes the oil to reach the level of the outlets near the top and flow into the adjacent filtering cylinders, around which specially prepared cloth is wound and in the passage of the oil through the body of the cloth it is entirely freed from every vestige of impurity not previously eliminated by gravity.

Full information concerning this system will be gladly supplied by the Pittsburgh Gage and Supply Company to all who are interested.

Superheated Steam.

THE Providence Engineering Works, of Providence, R. I., becoming convinced some two years ago that in superheating lies the direction of progress in economical steam engineering, designed and built a single cylinder engine for using super-

heated steam, which is now in operation at the works of the Brown & Sharpe Manufacturing Company, and in August, 1901, having thoroughly investigated the superheating methods in use abroad, the company became licensees under the Schmidt system, thus securing the experience of one of the most successful utilizers of steam at temperatures of 600 degrees to 700 degrees F.; and it now has under construction engines to the amount of nearly 7,000 horsepower on this system.

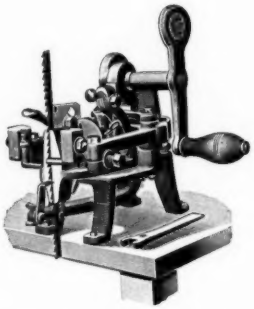
The Schmidt system consists of a superheater capable of raising steam to temperatures of 700 degrees to 750 degrees without appreciable deterioration, and with a life at least as long as that of the boiler with which it is used; of an intermediate receiver between the cylinders of compound engines, the office of which is to divide the superheat between the cylinders in various ratios as the load on the engine changes, thus protecting the high pressure cylinder from damage by excessive heat and greatly increasing the efficiency of the low-pressure cylinder; in the method of varying the superheat in the single cylinder engine in inverse proportion to the load, a necessary precaution when even high temperatures are used; and in various peculiarities of design in the cylinder, peculiarities necessary to fit it for the severe temperature and expansion effects of the medium.

The results obtained with engines of all sizes from 10 horse-power to 3,000 horsepower are remarkable. Various tests with steam at 650 degrees to 660 degrees at the engine cylinder and with engines developing 1,000 horse-power to 3,000 horse-power, show steam consumptions of 8.9 to 9 pounds of steam per horse-power per hour, corresponding to 197 to 200 British thermal units per second. The best saturated steam engines use from 12.5 to 13.5 pounds of steam per horse-power per hour, or 240 to 260 B. T. U. per second, a difference of 20 per cent. to 30 per cent of heat. The saving in coal varies from 15 per cent. to 25 per per cent., depending upon type of boiler and other local conditions. With boilers evaporating 10 to 11 pounds of water per pound of coal, which is now readily attainable, a horse-power can be developed for 1 pound to 1.1 pounds of coal.

The Providence Engineering Works has, as stated, a number of engines of various sizes under construction, and is prepared to guarantee all features of the installation, including heat consumption.

Saw-Blade Setting Machine.

THE "Equal Blow" setting machine for band-saw blades, is the first and only setting machine in which two teeth are set, one in either direction, by two hammers which are pressed by the same spring and strike with equal force at the same instant.



The blades are left straight by this process. There is no chance of buckling them, nor is there any possibility of breaking off teeth, as is too often the case with pressure methods. The saw passes through a spring-pressed vise, the jaws of which hold it firmly but yield when the saw is fed or drawn upward. If the saw is of uneven temper, it is simply necessary to adjust the movable stops. The amount of set is in view of the operator all the time, and can be increased or diminished by adjusting screws which regulate the force of the blow or the travel of the hammers.

As the teeth do not strike an anvil, they are not dulled or injured in the least, and the machine will give a much more even set than where the tooth is pushed or crowded, without the liability of springing back upon the removal of pressure.

This machine will set an ordinary saw in from three to five minutes, and the blades can be set without removal, or at the bench, as desired. It is manufactured by the New Britain Machine Co., of New Britain, Conn., who will supply further information.

Industrial Notes.

—The British Westinghouse Electric & Manufacturing Company's plant at Trafford Park, Manchester, will be in full working operation by July. Already, it is stated, over 300 men are employed in the pattern carpenter shops. The company being desirous of securing the services of English electricians who have gone through an "Americanizing" process, some thirty-five young Britishers, mostly college men and who had served a five-year aprenticeship in English shops, were brought over here about two years ago and have been trained in modern electrical machinery methods, etc., in the Westinghouse shops at Pittsburg. They will have responsible positions in the Manchester works. Twenty-five American experts will also have charge of various work in the new British plant. Inside of a year, it is said, everything pertaining to electrical machinery, etc., will be turned out by the English company entirely independent of the Pittsburg plant.

—The Minster Machine Co., Minster, O., is making extended improvements to their plant. A spacious building is being erected to be used for a foundry, which is being equipped with pulley molding machines and other modern machinery. Pulley finishing machines are also being added, and the entire plant is expected to be in full operation within a few weeks. In the future the company will devote its entire time to the manufacture of friction clutches and plain pulleys.

—The Engine Builders' Association of the United States held a meeting at the Schenley Hotel, Pittsburg, on May 22nd and 23rd. After a welcoming address by President W. M. Taylor, the following papers were read: Engine Forgings, by H. F. J. Porter, New York; Engine Requirements for the Parallel Operation of Alternators, by E. M. Tingley, Pittsburg; Piping Materials for Steam Plants, by John B. Berryman, Chicago; The Requirements for the Paralleling of Alternators as viewed by the Engine Builders, by H. M. Langwell, Pittsburg.

—A Locomobile has been sold to Lord Salisbury. Advice has also been received from The Locomobile Company of America's London office to the effect that a Style No 2 Locomobile arrived third in the "Paris-Nice Tour," or Caravan. The distance, 1,033 kilometers, (642 miles), was made in 46 hours, 20 minutes, actual running time. The Locomobile was preceded by two cars, one of 20 H. P. and the other 16 H. P. Out of the 40 cars that started from Paris, only fifteen arrived. The carriages taking part in the tour were those going from Paris to Nice to enter the trials to be held at the latter city. Two Locomobiles were sent from Paris, one run by Mr. Ginder and the other by Mr. Barriere. The car that Ginder ran was an ordinary Style No. 2 Locomobile. Below are the distances made each day: Paris to Sens, 108 kilometers; Sens to Dijon, 213 kilometers; Dijon to Lyons, 203 kilometers; Lyons to Avignon, 237 kilometers; Avignon to Draguiguan, 197 kilometers; Draguiguan to Nice, 75 kilometers. At the Nice trials a Locomobile made the ten-mile hill climb in thirty-two minutes.

—Consul W. S. Hollis reports from Lourenzo Marquez, South Africa, that, in a recent conversation with Senhor Albers, head of the harbor commission, he was informed that it is intended to make that port a great coaling station. Senhor Albers particularly requested to be put in communication with people in the United States who could supply him with the most economical and up-to-date coal-handling appliances, such as trestles, cranes, and machinery for delivering coal from freight cars (3-foot 6-inch gauge) into the holds and bunkers of vessels. Any written or printed matter addressed to the consul will be submitted to Senhor Albers.

—The Bucyrus Gold Dredging Company has recently purchased from the Westinghouse Electric & Manufacturing Co., of Pittsburg, a large amount of electrical machinery for the operation of the former's dredges in California, the chief point of activity at the present time being on the Feather River, at Oroville. Each dredge costs from $40,000 to $75,000, and its operation is accomplished entirely by electric motors, of an aggregate capacity of 75 H. P. to 200 H. P., the current for which is obtained from long distance transmission companies, operating in this neighborhood.

—The Philadelphia Pneumatic Tool Co.'s new shops at 21st St. and Allegheny Ave., Philadelphia, are practically complete and will afford greatly increased facilities

for a large and growing business. This campany has late placed upon the market two new sizes of rotary drills, and has perfected an improved riveting hammer, which is being made in three sizes, of capacities ranging from ¼ inch to 1¼ inch rivets. Orders aggregating nearly two hundred tools have recently been received from one of the largest shipyards in the country, and these, together with a lot of railroad and other trade, make an unprecedented rush of business. The Philadelphia Pneumatic Tool Co. will have an elaborate display of tools in a working exhibit at the Convention of Master Mechanics and Master Car Builders, at Saratoga, June 18 to 25.

—The J. A. Fay & Egan Co., of Cincinnati, the well known manufacturers of wood-working machinery, will be represented at the Saratoga convention of the Master Mechanics and Master Car Builders by their second vice-president, Mr. A. N. Spencer, and all who attend the convention are cordially invited to call upon him in the exhibit department.

—The Tennessee Coal, Iron, and Railroad Company has signed a contract for a chemical treating process filtering plant with the Pittsburg Filter Manufacturing Company, which will cost $35,000. The plant will be located at Ensley and will furnish water for the iron, steel, coal and coke plants at Ensley and Pratt City, Ala. Its capacity will be two and a half million gallons of water per day. The plant is to be completed within ninety days. Seven car loads of tanks and material will be brought there for the new plant.

—The Schaeffer & Budenburg Manufacturing Company, a corporation organized under the laws of the state of New York, will hereafter carry on the business formerly conducted by the New York branch of Schaeffer & Budenberg.

—H. W. Caldwell & Son Company, Chicago, Ill., have recently opened a sales and engineering office in New York City, the address being Room 410, 95 Liberty street. This office is in charge of Mr. R. T. Pearce, mechanical engineer, and it is the intention of the Caldwell Company to give the eastern trade personal attention through this branch. Through their extensive acquaintance with their special line of elevating, conveying and power transmitting machinery they will no doubt be able to render efficient engineering assistance to any one interested in this line of machinery.

Removals.

—To meet the demand of increasing business, The Merwarth Metallic Gasket Co. have moved from 107 Liberty St. into larger quarters in the Beard Building at 120 Liberty Street, Rooms 604 and 605.

—The McKiernan Drill Co. have changed their address to 170 Broadway, New York. Telephone, 6281 Cortlandt.

—Spon & Chamberlain, the publishers of engineering books, after having been at 12 Cortlandt St. for fifteen years, have removed to the Liberty Building, 123 Liberty St., New York.

—The Massachusetts Fan Co., has removed its factory and principal office from Boston to Bedford Street, Riverview Station, Waltham. The new factory is in a convenient suburb of the New England metropolis. The city office remains at 53 State Street, Boston.

—The Sprague Electric Company has found it necessary to move its Boston office into new and larger quarters to enable it to handle the increasing business in the New England district. The company has taken a suite of offices in the Weld Building, 176 Federal Street, which is one of the most desirable office buildings in Boston. The location is extremely good and is convenient to the South Terminal Station which is almost oposite. Mr. H. C. Farnsworth continues as Manager of the Boston office. He has recently added to his staff Mr. George D. Simmons, who was formerly Superintendent of the Hawes Electric Company.

—The William S. Haines Company have moved their office to 136 and 138 South Fourth St., Philadelphia.

—The Lehigh Valley Railroad announces that its old Mauch Chunk station will be abandoned, and all passenger business in future will be conducted at the station that has been heretofore known as East Mauch Chunk. This move has been contemplated for some time, owing to the extreme curve at the old station, which required a helper to start heavy trains out of the station. The present station at which passenger trains stop at Mauch Chunk is

more conveniently located to the city than the old one.

Personal.

—Mr. C. M. Levey has been appointed General Manager of the Hannibal & St. Joseph Railroad, St. Louis, Keokuk & Northwestern Railroad, Kansas City, St. Joseph & Council Bluffs Railroad, Chicago, Burlington & Kansas City Railroad, Chicago, Burlington & Quincy Railway Company, lessee, with headquarters at St. Louis.

—Mr. Howard Elliott has been elected Second Vice-President of the Chicago, Burlington & Quincy Railway Co., having charge of the maintenance and operation of all their lines, with office in Chicago.

—Mr. Nelson Miles Beach, the Treasurer of the Bridgeport Brass Company, died on Wednesday, March 19, at his late residence in Bridgeport, Conn.

—Col. Allan C. Bakewell, General Manager of the Sprague Electric Company, has recently been elected Second Vice-President of the Pennsylvania Society of New York.

—Mr. W. M. McFarland, Acting Vice-President of the Westinghouse Electric & Mfg. Company, delivered a lecture on "Electric Power Distribution in Manufacturing" at Cornell University on Friday, May 9th. The several different systems of distribution and their relative advantages were discussed and the manner of applying electric motors to machinery was illustrated by a large collection of stereopticon views.

—Mr. J. H. Watt, President of The Watt Mining Car Wheel Co., died recently, at the age of sixty-three, at Philadelphia, Pa., and his interment took place at Barnesville, O. Mr. Watt, while having three brothers associated with him in the business, was the founder of the concern, and its active and efficient head, as well as the best known citizen of Barnesville, and a leader in all the affairs of that town. His acquaintance with mining men was probably as extended as that of any man in the United States. The business will be continued without other change than the promotions in the scale of officers made necessary by Mr. Watt's death.

NEW CATALOGUES AND TRADE PUBLICATIONS

These catalogues may be had free of charge on application to the firms issuing them. Please mention The Engineering Magazine when you write.

Air Compressors.

A large, handsomely illustrated catalogue (B, 1902), containing a great deal of useful and interesting information about air compressors and their auxiliary machinery. J. Geo. Leyner, Denver, Colo.

Air-Lift Pump.

Illustrated booklet setting forth the advantages of compressed air pumping, and of the Carter air lift in particular, with descriptions of various applications. Ralph B. Carter, 26 Cortlandt St., New York.

Arc Lighting.

Bulletin No. 1,023, devoted to the multiple system of alternating current enclosed arc lighting for street service, with illustrated descriptions of lamps, transformers, "sure grip" pulleys and other details. Fort Wayne Electric Works, Fort Wayne, Ind.

Automobiles.

A handsome, well-illustrated pamphlet, setting forth the advantages of the "Milwaukee" steam automobiles, with descriptions of the vehicles and their details. The Milwaukee Automobile Co., Milwaukee, Wis.

Boilers.

Catalogue with illustrated descriptions and specifications of fire and water-tube boilers and boiler settings, grate bars, steel tanks, self-supporting steel stacks, etc. E. Keeler Company, Williamsport, Pa.

Calculagraph.

A pamphlet by Henry Abbott, reprinted from the "Electrical Engineer," showing the advantages of the calculagraph for

timing toll messages in telephone exchanges. The Calculagraph Company, 9-13 Maiden Lane, New York.

Chimneys.

Catalogue containing illustrated descriptions of chimneys built of perforated radial brick, a construction possessing many advantages and having a handsome appearance. Table of chimney boiler horse power. Adam Weber Sons, Park Row Building, New York.

Combustion.

A pamphlet with an illustrated description of the "Hydro-Carbon" system of fuel combustion for steam boilers, in which a specially designed door apparatus is substituted for the ordinary fire door, thereby forming an induced draft and promoting perfect combustion. Steam Boiler Equipment Co., 20 West Houston St., New York.

Conveyors.

Catalogue No. 67, with illustrations and descriptions of "Century" rubber belt conveyors, pulley carriers, trippers, belting, bucket elevators, apron conveyors, crushers, screens, and other mining and handling equipment. The Jeffrey Mfg. Co., Columbus, Ohio.

Cooling Towers.

Catalogue No. 1, with well illustrated descriptions of Alberger cooling towers, both natural draft and forced draft. Alberger Condenser Company, 95 Liberty St., New York.

Corliss Engines.

Pamphlet illustrating Corliss steam engines, with directions for their erection, adjustments and operation. The Lane and Bodley Co., Cincinnati, Ohio.

Cranes.

Bulletin No. 10, devoted to standard makes of chain block apparatus, with illustrated descriptions of chain block traveling cranes and standard I beam trolleys. Pawling and Harnischfeger, Milwaukee, Wis.

Daimler Motor.

A pamphlet describing gasoline engines and accessories for launches, yachts and automobiles, with handsome illustrations of various types of vessels and vehicles fitted with these motors. Daimler Manufacturing Company, Long Island City, New York.

Drawing Materials.

A large and handsome catalogue of 345 pages, illustrating and describing all kinds of drawing instruments and materials and surveying instruments. Eugene Dietzgen Company, Chicago, New York and San Francisco.

A comprehensive catalogue and price list of drawing instruments and materials, surveying instruments, etc. Schwencke, Kirk & Co., 26 Church St., New York.

Dynamos.

Bulletin No. 101, devoted to direct-current generators of the single field coil type, with illustrated descriptions of the machines, their details and accessories, diagrams and tables. Sprague Electric Company, 527-531 West 34th St., New York.

Electric Machines.

Bulletin No. 13, devoted to engine type generators, with illustrated descriptions of continuous-current, direct-connected dynamos and accessories for lighting, power and railway purposes. Telegraphic code and table of dimensions of dynamos. The Third Supplement to this Bulletin contains a partial list of Crocker-Wheeler engine type generators now in use, or for which orders have been entered. Crocker-Wheeler Company, Ampere, N. J.

Bulletin No. 14, devoted to large sizes of belt-type machines, with illustrated descriptions of continuous-current dynamos and motors operating through belting, and their accessories. Diagrams of connections and dimensions, tables of weights and sizes, and telegraphic code. Crocker-Wheeler Company, Ampere, N. J.

Bulletin No. 16, describing belt-type, bipolar electric motors, in sizes from 1½ to 2 horse power, with illustrations, diagrams, tables, and telegraphic code. Crocker-Wheeler Company, Ampere, N. J.

Bulletin No. 17, with descriptions of motor-dynamos and dynamotors for telephone and telegraph plants, and illustrations of the machines and of plants in op-

eration. Crocker-Wheeler Company, Ampere, N. J.

Bulletin No. 18, reprinted from the "American Electrician," describing the electric plant of the graphite factory of the Joseph Dixon Crucible Co., where electric machinery is applied to a great variety of uses. Crocker-Wheeler Company, Ampere, N. J.

Bulletin No. 20, devoted to belt-type multipolar machines in small sizes, with illustrations of electric motors operating various machines, tables, diagrams and telegraphic code. Crocker-Wheeler Company, Ampere, N. J.

Bulletin No. 55, devoted to direct current factory motors and small generators, with illustrated descriptions of electric motors applied in various ways. Also, efficiency curves, diagrams and tables of dimensions, and telegraphic code words. Rochester Electric Motor Company, Rochester, N. Y.

Electric Marine Apparatus.

Bulletin No. 133, with illustrated descriptions of marine generating sets, launch motors, dynamos for charging storage batteries, and gas-engine igniters. The Holtzer-Cabot Electric Co., Boston (Brookline), Mass.

Electric Railway.

Bulletin No. 6, containing a well illustrated paper on the Grand Rapids, Holland, and Lake Michigan Rapid Railway, with the electric power station and equipment. Arnold Electric Power Station Company, Engineers and Contractors, Marquette Building, Chicago, and Transit Building, New York.

Factory Specialties.

Bulletin No. 782, with illustrations calling attention to the Ness Automatic Intercommunicating Telephone System, "Acme" Watchman's Time Detector, gas-engine igniters, electric motors and dynamos. The Holtzer-Cabot Electric Co., Boston (Brookline), Mass.

Fan Motors.

Folder, with illustrations and price lists of desk pattern, wall bracket and suspended universal electric fans. The Holtzer-Cabot Electric Co., Boston (Brookline), Mass.

Fire Engines.

A large, handsomely printed and illustrated catalogue of steam fire-engines, and also fire-boat pumps, steam pumps and other fire engine and pumping machinery. American Fire Engine Co., Seneca Falls, N. Y., and Cincinnati, Ohio.

Forges.

Neat catalogue of portable forges, hand blowers, blacksmith drills, punches, shears, bar cutters, tire benders and upsetters. The line of portable forges is particularly complete. Buffalo Forge Company, Buffalo, N. Y.

Gas Engine Igniters.

Bulletin No. 136, describing electrical igniters for gas and gasoline engines, with illustrations and diagrams. The Holtzer-Cabot Electric Co., Boston, (Brookline) Mass.

Hair Insulator.

Two neat booklets setting forth the advantages of the Keystone Hair Insulator an odorless and vermin-proof fabric. One describes it as an interlining in buildings for general insulating purposes and for deadening sound. The other is devoted more particularly to its use for refrigerating and cold-storage compartments. H. W. Johns-Manville Co., 100 William St., New York.

Hydraulic Engine.

A pamphlet containing an illustrated description and schedule of prices of the Niagara Hydraulic Engine, a modern development of the old-fashioned hydraulic ram, which will operate with very small heads of water. Niagara Hydraulic Engine Co., Chester, Pa.

Machine Tools.

Attractive booklet, illustrating a few standard types of American machine tools, such as lathes, planers, boring and turning mills, drilling machines, shaping machines, steam hammers and electric traveling cranes. Niles-Bement-Pond Co., 136-138 Liberty St., New York.

Molding Machine.

Catalogue No. 6, with a well illustrated description of the Farwell Automatic Molding Machine and its manner of operation. The Adams Company, Dubuque, Iowa.

Pipe.

Catalogue of galvanized and copper pipe and fittings, including Ritchie's patent corrugated expanding conductor, standard speaking tube, spiral lock-seam pipe, eaves trough, elbows and shoes. Also, folder describing tin-lined and lead-lined iron pipe. Lamb and Ritchie, Cambridgeport, Mass.

Pneumatic Tools.

Special circular No. 19, devoted particularly to tools for stone and marble work, but also containing information about compressors, traveling cranes, hoists and other pneumatic apparatus. Very well illustrated. Chicago Pneumatic Tool Company, Monadnock Block, Chicago, and 95 Liberty St., New York.

Presses.

Illustrated descriptive sheets of presses of various kinds: foot, screw, hand, arch, and adjustable stroke drawing and broaching. Mossberg and Granville Mfg. Co., Providence, R. I.

Pumps.

Handsome, cloth-bound, illustrated catalogue (53rd edition) of hand and power pumps, hydraulic and pumping machinery for all purposes. Telegraph cipher code. Rumsey & Co., Limited, Seneca Falls, New York.

Tastefully designed and well illustrated catalogue of steam pumps, pumping engines, power pumps, condensers, cooling towers, evaporating and distilling apparatus, ash ejectors, etc., with tables of useful information and engineering data. M. T. Davidson, 43-53 Keap St., Brooklyn, N. Y.

Refrigeration.

Booklet and series of folders devoted to ice-making and refrigerating machinery. Both sulphur-dioxide and ammonia machines are described, and their relative advantages discussed. The Singer Automatic Ice Machine Company, Bridgeport, Conn.

Safety Stop.

Illustrated pamphlet, describing the Wright automatic safety stop and speed limit for steam engines and also, as an independent device, for quickly closing valves in case of steam pipe breaking, engine overspeeding or any other accident. J. K. Wright, 136 Liberty St., New York.

Steam Hammers.

A handsome catalogue with illustrated descriptions of steam hammers with several styles of frame, tilting hammers and drop hammers. Also, general instructions and code list. Bement, Miles & Co., branch of Niles-Bement-Pond Co., Philadelphia, Pa.

Steel Rolled Shapes.

Booklet giving illustrated list of angles, channels and other rolled shapes, with weights and sizes, harrow teeth and other Bessemer steel products manufactured by the Cambridge Rolling Mill Company, Cambridge, Ohio.

Storage Batteries.

Bulletin No. 71, containing an article by W. H. Palmer, Jr., reprinted from "The Electrical World and Engineer," on "The Storage Battery in the Commercial Operation of Electric Automobiles." The Electric Storage Battery Co., Philadelphia.

Varnish.

A very neat, flexible cloth booklet on specifications for testing insulating varnishes, of particular interest to the electrical trade. The Sterling Varnish Co., Pittsburg, Pa.

Ventilators.

A new catalogue, illustrated with half-tone engravings, describing many different types and sizes of ventilators and the manner of placing them on chimneys and roofs. Buffalo Forge Company, Buffalo, N. Y.

Wire Rope.

Well printed and comprehensively illustrated book, by William Hewitt, M. E., on the application of wire rope to surface and underground haulage, hoists and inclined planes, with information concerning track rollers, mine cars and tipples. The Trenton Iron Company, Trenton, N. J.

An illustrated catalogue of wire rope and cordage of every description, wire rope tramways, blocks, sheaves, hooks and a great variety of accessories. A. Leschen and Sons Rope Co., St. Louis, Mo.